1

INSTALLATION RESTORATION PROGRAM

STAGE 3

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

ELMENDORF AIR FORCE BASE, ALASKA

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TECHNICAL SERVICES DIVISION (AFOEHL/TS)

BROOKS AIR FORCE BASE, TEXAS 78235-5501

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This report presents and discusses the results of a remedial investigation and feasibility study (RI/FS) for 32 sites at Elmendorf AFB, AK as part of the USAF Installation Restoration Program. Several sites were combined during the field investigation program; therefore a total of 29 sites are discussed in this RI/FS report. In addition several other locations were sampled such Ship Creek, Base drinking wells, and five additional wells were installed to determine basewide hydrogeology and background levels. Of the original 32 sites, 10 sites were either landfills or disposal sites, 8 sites were near buildings that have had or still have dry wells incorporated into there floor drain systems, 1 site was a PCB transformer storage area, 11 sites are areas were fuel spills have occurred, the last 2 sites include Cherry Hill Ditch and a fuel seep near the golf course.

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The field investigation program included site reconnaissance; geophysical techniques; soil gas surveys; subsurface explorations; and groundwater, surface water, soil, and sediment acquisition and analysis. A total of 57 monitoring wells were installed, 36 additional borings were drilled, tested, and backfilled, 4 hand augered holes were established, tested, and backfilled, and two observation trenches were excavated. A total of 527 soil samples were taken and 175 of the soil samples were sent to the laboratory for analysis. In addition, 79 groundwater samples were taken from the monitoring wells.

The main contaminants found at the Elmendorf AFB sites included total petroleum hydrocarbons and other fuel contaminants such as benzene, ethylbenzene, toluene, and xylenes; solvents such as trichloroethene and tetrachloroethene, polycyclic aromatic hydrocarbons such as fluoranthene and pyrene, and pesticides such as 4,4'-DDT and 4,4'-DDD. During the RI the sites were prioritized according the level of contamination at each site. Of the new total of 29 sites, 5 were included in the FS and 7 of the sites were determined to need no further action. The remaining 17 require further investigation for better characterization and to ultimately complete either an FS or no further action documentation.

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PREFACE

The IRP Stage 3 Remedial Investigation/Feasibility Study at Elmendorf AFB, Alaska was performed under Contract No. F33615-87-D-4021, Order No. 0002. The report provides the background for the 32 sites investigated under this order; describes the field work performed; presents the resultant findings and conclusions; and makes recommendations for the disposition of each site.

Vernon M. Reid, Project Manager, directed the efforts of Black & Veatch and critical subcontractor Woodward-Clyde Consultants. Key staff utilized in the field, study and report efforts included the following:

Sue Curtin	Project Leader (B&V)
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Robin Hamlet	Site Manager/Geologist (B&V)
Randy Rose	Site Safety Officer (B&V)
Robert Dugan	Geologist (WCC)
Sue Ban	Geologist (WCC)
Daniel Graham	Geologist (WCC)

Black & Veatch acknowledges the cooperation and support of numerous military and civilian staff at Elmendorf Air Force Base during this effort.

Special appreciation is directed to Mr. Mike Drewett and Captain Russell Godsave of the 21 CSG/DEEV for their timely assistance and support.

This work was accomplished between May 1988 and April 1989. Lt. Dale J. Dietzel, Technical Services Division, USAF Occupational and Environmental Health Laboratory (AFOEL/FS) was the Technical Monitor. Lt. Walt Migdal assumed Technical Monitor responsibility for this project in March 1989.

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IRP STAGE 3 RI/FS
ELMENDORF AFB, ALASKA
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EXECUTIVE SUMMARY

Elmendorf AFB is the largest Air Force installation in Alaska, and home of the Alaska Air Command Headquarters. In the 1940's, the U.S. War Department designated the base Fort Richardson, the airfield area Elmendorf Field. The name was changed to Elmendorf AFB in 1948. In 1951, the Army moved to a new Fort Richardson, and jurisdiction of the base was transferred to the Department of the Air Force.

Elmendorf AFB is located within the Cook Inlet-Susitna Lowland subdivision of the Coastal Trough Physiographic Province. The base, located on 13,130 acres, is bordered on the south by the Municipality of Anchorage, on the east by the U.S. Army's Fort Richardson, and on the northeast by the Knik Arm of Cook Inlet. A discussion of the environmental setting of Elmendorf AFB is included in Chapter II.

Premobilization for the Stage 3 RI/FS began in May 1988. The Stage 3 field investigation began June 20, 1988 and was completed, except for the survey, on August 27, 1988. Surveying was conducted in October 1988. Results of the survey were available in November 1988. Sample analyses were completed in November 1988.

A field investigation program was conducted at 32 IRP sites to provide data to identify and characterize contaminants. Some sites have been combined, resulting in 29 sites, as identified on Table 1. Three other sites were investigated to provide information on site geology and hydrogeology. Details of the field investigation program are included in Chapter III. Initial investigative procedures included site reconnaissance, geophysical techniques and soil gas surveys. These procedures established drilling boundaries and identified generalized zones of high volatile organic contamination. Based on these findings, conventional geotechnical and engineering methods were utilized to determine subsurface conditions and facilitate sampling. The initial geophysical techniques included ground-penetrating radar,

TABLE 1. DESIGNATION AND DESCRIPTION OF 32 IRP SITES

Site Designation	Site Description
D-3	Landfill
D-5	Landfill
D-7	Sanitary Landfill
D-13	Disposal Site
D-15	POL Sludge Disposal Site No. 1
D-16	POL Sludge Disposal Site No. 2
D-17	Shop Waste Disposal
IS-1	Building 42-400 Floor Drain
IS-2	Building 42-425 Floor Drain
IS-3	Building 42-550 Floor Drain
IS-4	Building 42-300 Floor Drain
IS-5	Building 43-410 Floor Drain
IS-6	Building 43-450 Floor Drain
IS-7	Building 21-900 Floor Drain
IS-8	Building 36-060 Floor Drain
S-6	PCB Transformer Storage Area
SP-1	Diesel Fuel Line Leak
SP-2/6	JP-4 Fuel Line Leak and Diesel Fuel Spill, Building 22-013
SP-4	Railroad Maintenance Area Oil Spill
SP-5/5A	JP-4 Tank Spill
SP-7/10	Pumphouse No. 3
SP-11	JP-4 Fuel Line Leaks
SP-12	JP-4 Fuel Line Leak
SP-13	Diesel Fuel Line Leak
SP-14	MOGAS Spill
SP-15	AVGAS Spill
NS-1	Cherry Hill Ditch
NS-2	DRMO Scrap Pile
NS-3	Seep No. 4, Golf Course

soil conductivity, and pipe and cable location. Ground-penetrating radar was used to locate landfill boundaries on Sites D-3, D-5, and D-13 and document buried utilities on various sites. Soil conductivity surveys were also used to locate landfill boundaries, identify buried metallic objects such as pipes and debris, and distinguish between soil strata on Sites IS-1 though IS-8 and SP-5. A pipe and cable locator was used at Sites D-3, D-13, D-15, IS-1 through IS-8, and SP-5/5A. The pipe and cable locator was used primarily to verify the absence of buried cables or pipes at proposed test boring locations. The instrument was also used to assist in identification of buried metallic objects. Soil gas surveys were conducted at 11 sites to delineate relative concentrations of volatile organic compounds.

Four types of subsurface explorations were utilized. A total of 57 monitoring wells were installed, 36 additional borings were drilled, tested, and backfilled, 4 hand augered holes were established, tested, and backfilled, and 2 observation trenches were excavated. Split spoon samples from borings were collected at 5-foot intervals to a depth of 30 feet and at 10 foot intervals thereafter unless contamination was encountered at depths greater than 30 feet. In that case, 5 foot sampling intervals were maintained through the zone of contamination. The samples and cuttings were scanned for volatile organic compounds (VOCs) using an HNu photoionization meter (HNu). Materials were visually classified according to the Unified Soil Classification System. Water level measurements were attempted at the first sign of very damp or wet soil. Water level was also measured at the completion of drilling and again after well construction and development.

Boring logs were kept for each test boring and monitoring well. These logs contain general information about the hole such as boring number, date started and completed, driller's code, logger's code, and

borehole depth and diameter. In addition, specific information concerning sample method, sample depth intervals, sample recovery, material recovered, sample class/code and sample identification was included. Results of all field measurements including water level, VOC, temperature, and the presence/absence of visual contamination and odor were also recorded on the logs.

Following the completion of drilling and acquisition of all pertinent information from the boring, the hole was either completed as a monitoring well or as a test boring. The test borings were backfilled with a volclay slurry and a cap of cement was added to the top 1 foot. The monitoring wells were of PVC construction.

Twenty monitoring wells were logged using a portable geophysical borehole logger that measured natural gamma radiation in the soil. Results of the geophysical borehole survey were compared with the boring logs.

Soil, sediment, groundwater, surface water, containerized material, and soil gas samples were collected during the Stage 3 field investigation. Soil gas surveys were performed at 11 sites, with a total of 383 probes installed. Soil samples were collected from the boreholes at the appropriate intervals. A total of 527 soil samples were taken at 19 sites and 175 soil samples were sent to the laboratory for analysis. In addition, 79 groundwater samples were taken from monitoring wells established in the boreholes at the 19 sites. Seven surface sediment and 7 surface water samples were also collected.

The contaminated cuttings material was collected and containerized during the drilling operation. There were a total of 7 barrels (numbered 1 through 7) containing cuttings material, with 1 laboratory sample composited from every 3 barrels (sample numbers 123, 456, and

7). Decontamination residue was also containerized into 3 barrels. The contents of these 3 barrels were composited for 1 laboratory sample (sample number 8910) and analyzed to assist in their disposition.

The laboratory results and field data were evaluated for each site. The results and significance of findings of the field investigation program are presented in Chapter IV. Table 2 presents a summary of the contamination detected at each site, the recommended action, and the rationale for the recommended action. A more detailed discussion of the recommended action at each site is included in Chapter VI. Since listing all detected contaminants would be very cumbersome, only contaminants detected in water samples which exceed state of Alaska and EPA Primary Drinking Water Standards are listed. All volatile organic contaminants detected in soil samples are listed because there are no EPA or State of Alaska regulations for soil contamination.

Of the 32 IRP sites investigated, 7 require no further action, 18 require further investigation, and a feasibility study was completed to evaluate remedial actions for the remaining 7 sites. The feasibility study is presented in Chapter V.

TABLE 2. CONTAMINANTS DETECTED AND RECOMMENDED ACTIONS FOR STAGE 3 IRP SITES

Site No.	Site Description	Contaminants Detected		Recommended Action	Rationale
		Water	Soil		
D-3	Landfill	No organic contaminants detected. No metals detected above background levels.	4-methylphenol No other contaminants detected. No metals detected above background levels.	No further action.	Site adequately characterized to determine no significant impact to human health or environment will occur.
D-5	Landfill	Barium, Lead, Mercury, Beryllium, Chromium, Copper, Iron, Manganese exceed cleanup levels. Various purgeable halocarbons detected, but below cleanup levels.	Not Sampled	Combined with Sites D-7, D-13, and NS-2 and assigned high priority for further investigation.	Contaminant levels exceed State of Alaska Primary Drinking Water Standards and evidence of off-site migration.
D-7	Active Landfill	Vinyl Chloride, Lead Chromium detected above cleanup levels. Other volatile organics detected did not exceed cleanup levels. Other metals not above background levels.	Not Sampled	See Site D-5.	See Site D-5.
D-13	Landfill	Various organic contaminants detected below cleanup levels.	Trichlorofluoromethane detected at low concentrations.	See Site D-5.	See Site D-5.
D-15	POL Sludge Disposal Site No. 1	Not Sampled	TPH detected at concentrations exceeding ADEC interim cleanup guidelines.	Low priority for further investigation.	TPH contamination in soils ranged from nondetectable to 2590 mg/kg. Installation of monitoring wells to see if groundwater is contaminated is recommended.
D-16	POL Sludge Disposal Site No. 2	Not Sampled	TPH detected at concentrations exceeding ADEC interim cleanup guidelines.	A feasibility study was completed. The recommended remedial alternative includes landfilling contaminated soil in local sanitary landfill and groundwater monitoring.	Total petroleum hydrocarbon (TPH) contamination ranged from nondetectable to 8160 mg/kg in soil samples. Groundwater monitoring is required to determine if groundwater is contaminated. VOC analysis should be used to determine if waste is hazardous.

NOTE: Cleanup levels are discussed in Section 4.1.1.

TABLE 2 (Continued). CONTAMINANTS DETECTED AND RECOMMENDED ACTIONS FOR STAGE 3 IRP SITES

Site No.	Site Description	Contaminants Detected: Water	Contaminants Detected: Soil	Recommended Action	Rationale
D-17	Shop Waste Disposal Site	Trichloroethene detected above MCL. 1,2-Dichloroethane, Benzene, TPH were detected below cleanup levels. Barium, arsenic, and manganese concentrations slightly exceed background levels, but do not exceed primary cleanup standards.	TPH exceeded ADEC interim cleanup guidelines. Benzo(a)pyrene exceeded cleanup level. Other organics detected, including PAHs 4,4'-DDD and 4,4'-DDT did not exceed cleanup levels. Metals did not exceed background concentrations.	Medium priority for further investigation.	Contaminant levels exceed State of Alaska and EPA Primary Drinking Water Standards and potential for offsite migration.
IS-1	Floor Drain at Building 42-400	Benzene and Xylenes exceeded cleanup levels. Cadium slightly exceeded both cleanup levels and background concentrations. Other organics detected did not exceed cleanup levels. Other metals did not exceed background levels.	TPH detected above ADEC interim cleanup guidelines. Metals did not exceed background concentrations.	An FS was completed. The recommended remedial alternative includes groundwater collection, product recovery, groundwater treatment by air stripping, surface discharge, and additional groundwater monitoring.	Benzene, xylenes and total petroleum hydrocarbons (TPH) were detected above State of Alaska existing or proposed regulations. Product recovery and air stripping are proven technologies for removal of TPH and BETX, respectively. Additional investigation is necessary to define the extent of contamination.
IS-2	Floor Drain at Building 42-425	TPH below cleanup levels. Metals did not exceed backgroun concentrations.	Metals did not exceed background concentrations.	No further action.	Shallow groundwater is not utilized in this area. Site adequately characterized to determine no significant impact to human health or environment will occur.
IS-3	Floor Drain at Building 45-550	Alpha-BHC exceeded cleanup levels. TPH and delta-BHC detected, but no cleanup levels exceeded. Metals did exceed background concentrations.	Metals did not exceed background concentrations.	Medium priority for further investigation.	Contaminant levels exceed State of Alaska and EPA Primary Drinking Water Standards.

NOTE: Cleanup levels are discussed in Section 4.1.1.

TABLE 2 (Continued). CONTAMINANTS DETECTED AND RECOMMENDED ACTIONS FOR STAGE 3 IRP SITES

Site No.	Site Description	Contaminants Detected: Water	Contaminants Detected: Soil	Recommended Action	Rationale
IS-4	Floor Drain at Building 42-300	Alpha-BHC exceeded cleanup levels. Di-n-butylphthalate and 1,1,1-Trichloroethane were detected, but do not exceed cleanup levels. Metals do not exceed background concentrations.	TPH detected above ADEC interim cleanup guidelines, metals do not exceed background concentrations.	Medium priority for further investigation	Contaminant levels exceed State of Alaska and EPA Primary Drinking Water Standards.
IS-5	Floor Drain at Building 43-410	TPH detected but did not exceed cleanup levels. Chloroform detected below cleanup levels. Metals do not exceed background concentrations.	Bis(2-ethylhexyl) phthalate at low concentration. Metals do not exceed background concentrations.	No further action.	Site adequately characterized to determine no significant impact to human health or environment will occur.
IS-6	Floor Drain at Building 43-450	Trichloroethene detected above MCL. TPH, tetrachloroethane, and chloroform detected below cleanup levels. Metals did not exceed background concentrations.	1,2,4,5-tetrachlorobenzene and benzo(a)pyrene are above cleanup levels. Various other organic contaminants detected did not exceed cleanup levels. Metals did not exceed background concentrations.	Medium priority for further investigation.	Contaminant levels exceed State of Alaska and EPA Primary Drinking Water Standards and potential for offsite migration exists.
IS-7	Floor Drain at Building 21-900	Trichloroethene detected above MCL. TPH also detected. Metals did not exceed background concentrations.	No organic contaminants detected. Metals did not exceed background concentrations.	Medium priority for further investigation.	Contaminant levels exceed State of Alaska and EPA Primary Drinking Water Standards and potential for offsite migration exists.
IS-8	Floor Drain at Building 32-060	Trichloroethene exceeded MCL. TPH, toluene, 4-methyl-2-pentanome, 1,1-dichloroethane, and 1,1,1-trichloroethane also detected, but did not exceed cleanup levels. Metals did not exceed background concentrations.	No organic contaminants detected. Metals did not exceed background concentrations.	Medium priority for further investigation.	Contaminant levels exceed State of Alaska and EPA Primary Drinking Water Standards and potential for offsite migration exists.

NOTE: Cleanup levels are discussed in Section 4.1.1.

TABLE 2 (Continued). CONTAMINANTS DETECTED AND RECOMMENDED ACTIONS FOR STAGE 3 IRP SITES

Site No.	Site Description	Contaminants Detected: Water	Contaminants Detected: Soil	Recommended Action	Rationale
S-6	PCB Transformer Storage Area	Not Sampled	Aroclor-1260 detected below regulatory standards. No other PCBs detected.	No further action.	Site adequately characterized to determine no significant impact to human health or environment will occur.
SP-1	Diesel Fuel Line Leak	Benzene exceeded MCL. Toluene, ethylbenzene, and xylenes detected below cleanup levels. TPH exceeded cleanup levels.	TPH detected at levels exceeding ADEC interim cleanup guidelines.	High priority for further investigation.	Contaminant levels exceed State of Alaska and EPA Primary Drinking Water Standards and evidence of offsite migration exists. Benzene is a known carcinogen.
SP-2/6	Fuel Line Leak and Diesel Line Spill	Ethylbenzene, toluene, and xylenes detected. No cleanup levels exceeded. Water samples had a visible odor and sheen, thereby exceeding TPH cleanup levles.	TPH detected at levels exceeding ADEC interim cleanup guidelines.	Medium priority for further investigation.	Contaminant levels exceed State of Alaska and EPA Primary Drinking Water Standards and evidence of offsite migration exists.
SP-4	Railroad Maintenance Area Oil Spill	TPH and benzene exceeded cleanup levels. Toluene and ethylbenzene detected below cleanup levels.	TPH detected in 1 boring above interim ADEC cleanup guidelines. Metals did not exceed background concentrations.	Medium priority for further investigation.	Contaminant levels exceed State of Alaska and EPA Primary Drinking Water Standards and evidence of offsite migration exists.
SP-5/5A	JP-4 Tank Spill	TPH, benzene, ethylbenzene, toluene, and xylenes all exceeded cleanup levels.	TPH was detected above ADEC interim cleanup guidelines. Ethanol, ethylbenzene, toluene, xylenes, and methylene chloride also detected.	An FS was completed. The recommended remedial alternative includes groundwater collection, product recovery, groundwater treatment by air stripping, surface discharge, and additional groundwater monitoring. The groundwater collection system will include a trench along Loop Road to capture fuel seeps. Tanks and piping should be tested for leaks.	Visible evidence of contamination exists. Benzene, ethylbenzene, toluene, xylenes (BETX) and total petroleum hydrocarbon (TPH) were detected above State of Alaska proposed regulations. Product recovery and air stripping are proven technologies for removal of TPH and BETX, respectively. Tanks and piping should be leak tested to identify the source of contamination. Additional investigation is necessary to define the extent of contamination.

NOTE: Cleanup levels are discussed in Section 4.1.1.

TABLE 2 (Continued). CONTAMINANTS DETECTED AND RECOMMENDED ACTIONS FOR STAGE 3 IRP SITES

Site No.	Site Description	Contaminants Detected: Water	Contaminants Detected: Soil	Recommended Action	Rationale
SP-7/10	Pumphouse No. 3	Benzene, ethylbenzene, toluene, xylenes, and TPH all detected at concentrations exceeding cleanup levels.	Ethylbenzene, toluene, and xylenes detected below cleanup guidelines. TPH detected at concentrations exceeding ADEC interim cleanup guidelines.	An FS was completed. The recommended remedial alternative includes groundwater collection, product recovery, groundwater treatment by air stripping, surface discharge, and additional groundwater water monitoring.	BETX and TPH were detected above State of Alaska proposed regulations. Product recovery and air stripping are proven technologies for removal of TPH and BETX, respectively. Additional investigation is needed to define the extent of contamination.
SP-11	JP-4 Fuel Line Leak	TPH and benzene exceeded cleanup levels. Other chlorinated hydrocarbons detected, but no cleanup levels were exceeded.	Not Sampled	See Site SP-4.	See Site SP-4.
SP-12	JP-4 Fuel Line Leak	TPH detected but did not exceed cleaunp levels.	Not Sampled	No further action.	Site adequately characterized to determine no significant impact to human health or environment will occur.
SP-13	Diesel Fuel Line Leak	Not Sampled	TPH and low levels of PAHs.	Low priority for further investigation.	TPH was detected in one soil sample at a concentration of 44 mg/kg. In addition, surface soil samples contained polycyclic aromatic hydrocarbons. Installation of a downgradient groundwater monitoring well is recommended.
SP-14	MOGAS Spill	Lead slightly exceeds cleanup goal. EDB also detected.	TPH and 2-butanone below cleanup levels.	No further action.	Site adequately characterized to determine no significant impact to human health or environment will occur.
SP-15	AVGAS Spill	Benzene exceeds the MCL. TPH, ethylbenzene, and xylenes also detected.	Ethylbenzene, xylenes, and toluene detected below cleanup levels. TPH detected above ADEC interim cleanup guidelines.	An FS was completed. The recommended remedial alternative includes groundwater collection, groundwater treatment by air stripping, surface discharge, and additional groundwater monitoring.	Benzene and TPH was detected above proposed State of Alaska regulations. Air stripping is a proven technology for removal of BETX. Additional investigation is needed to define the extent of contamination.

NOTE: Cleanup levels are discussed in Section 4.1.1.

TABLE 2 (Continued). CONTAMINANTS DETECTED AND RECOMMENDED ACTIONS FOR STAGE 3 IRP SITES

Site No.	Site Description	Contaminants Detected: Water	Contaminants Detected: Soil	Recommended Action	Rationale
NS-1	Cherry Hill Ditch	Chloroform, 1,1,1-trichloroethane detected in water at concentrations below cleanup levels. Surface water had petroleum sheen and foam.	TPH and numerous PAHS. TPH and benzo(a)pyrene exceed cleanup levels. Metals detected did not exceed background levels.	Medium priority for further investigation.	Detection of TPH in surface water and stream sediment samples. Also presence of foam on water.
NS-2	DRMO Scrap Pile	Vinyl chloride and trans-1,2-dichloroethene were detected. Vinyl chloride exceeded cleanup levels. Metals did not exceed background concentrations.	Metals did not exceed background concentrations.	See Site D-5.	See Site D-5.
NS-3	Golf Course Seep	TPH and trichloroethene detected below cleanup levels.	TPH detected below ADEC interim cleanup guidelines.	No further action.	Site adequately characterized to determine no significant impact to human health or environment will occur.

NOTE: Cleanup levels are discussed in Section 4.1.1.

I. INTRODUCTION

1.1 PURPOSE OF THE IRP PROGRAM

The current Department of Defense (DOD) Installation Restoration Program (IRP) was instituted as a positive action to ensure compliance of military installations with existing environmental regulations as directed by the Defense Environmental Quality Program Policy Memorandum (DEQPPM) 81-5 dated 11 December 81 and implemented by U.S. Air Force (USAF) message dated 21 January 82. DEQPPM 81-5 reissued and amplified all previous directions and memoranda on the IRP.

DOD policy is to identify and fully evaluate suspected problems on DOD facilities associated with past hazardous material disposal sites, to control past hazardous material disposal sites, to control the migration of hazardous consituents, and to remediate any hazards to health, welfare, or the environment, that may have resulted from past generations on DOD facilities.

1.2 IRP PROGRAM ORGANIZATION

The IRP is the basis for the response actions on the Air Force installations under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, clarified by Executive Order 12316, and as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986. CERCLA is the primary legislation governing remedial actions at any past hazardous waste disposal sites. The IRP was a four-phased program designed to assure that identification, confirmation, quantification, and remedial actions are performed in a timely and cost-effective manner.

The purpose of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) is to effectuate the response powers and

responsibilities created by CERCLA. The plan applies to all federal agencies and is in effect for all navigable waterways and any releases or substantial threats of releases of hazardous substances to the environment.

The USAF has recently modified the IRP to make it similar to the EPA's integrated Remedial Investigation/Feasibility Study (RI/FS) in order to conduct RI/FS studies at USAF facilities in an integrated fashion rather than in a serial manner. Using this approach, preliminary remedial alternatives are identified and evaluated as additional information on the nature and extent of contamination is obtained. This approach permits the identification of potential remedial alternatives, contributing to a more explicit definition of data requirements for the feasibility studies.

Previously, the U.S. Air Force (USAF) has operated the IRP under a phased approach. A description of activities and objectives for each of the 4 phases in an IRP are presented herein.

Phase I - Installation Assessment/Records Search

Phase I identifies and prioritizes through records searches and personal interviews those past disposal sites that may pose a hazard to public health and/or the environment as a result of contaminant migration to surface or groundwaters, or have an adverse effect by its persistence in the environment. During this phase, it was determined whether a site requires further action to confirm an environmental hazard or whether it may be considered to present no hazard at that time. If a site required immediate remedial action, such as removal of abandoned drums, the action could proceed directly to Phase IV. Phase I was a basic background document for the Phase II study.

Phase II - Confirmation/Quantification

Phase II defined and quantified, by preliminary and comprehensive environmental and/or ecological surveys, the presence or absence of contamination, the extent of contamination, waste characterization (when required by the regulatory agency), and identified sites or locations where remedial actions are required in Phase IV. Research requirements identified during this phase were included in the Phase III effort of the program.

Phase III - Technology Base Development

Phase III develops a sound database upon which to prepare a comprehensive remedial action plan. This phase includes implementation of research requirements and technology for objective assessment of adverse effects. A Phase III requirement could be identified at any time during the program.

Phase IV - Operations/Remedial Actions

Phase IV includes the preparation and implementation of the remedial action plan.

Engineering Science conducted Phase I activities at Elmendorf AFB in 1983. Dames and Moore conducted Phase II Stage 1 and 2 in 1986 and 1987. Harding Lawson Associates prepared the Work Plan for Stage 3 activities in 1988. Black & Veatch with Woodward Clyde Consultants as a critical subcontractor conducted Stage 3 field activities during the summer and early fall of 1988. Additional field activities for sites which require additional IRP effort are scheduled for the summer of 1990.

1.3 ELMENDORF AFB HISTORY

Elmendorf AFB is the largest Air Force installation in Alaska, and home of the Alaskan Air Command Headquarters. In 1940, the U.S. War Department designated the base Fort Richardson, and the airfield area Elmendorf Field. The name was changed to Elmendorf AFB in 1948. In 1951, the Army moved to a new Fort Richardson, and jurisdiction of the base was transferred to the Department of the Air Force.

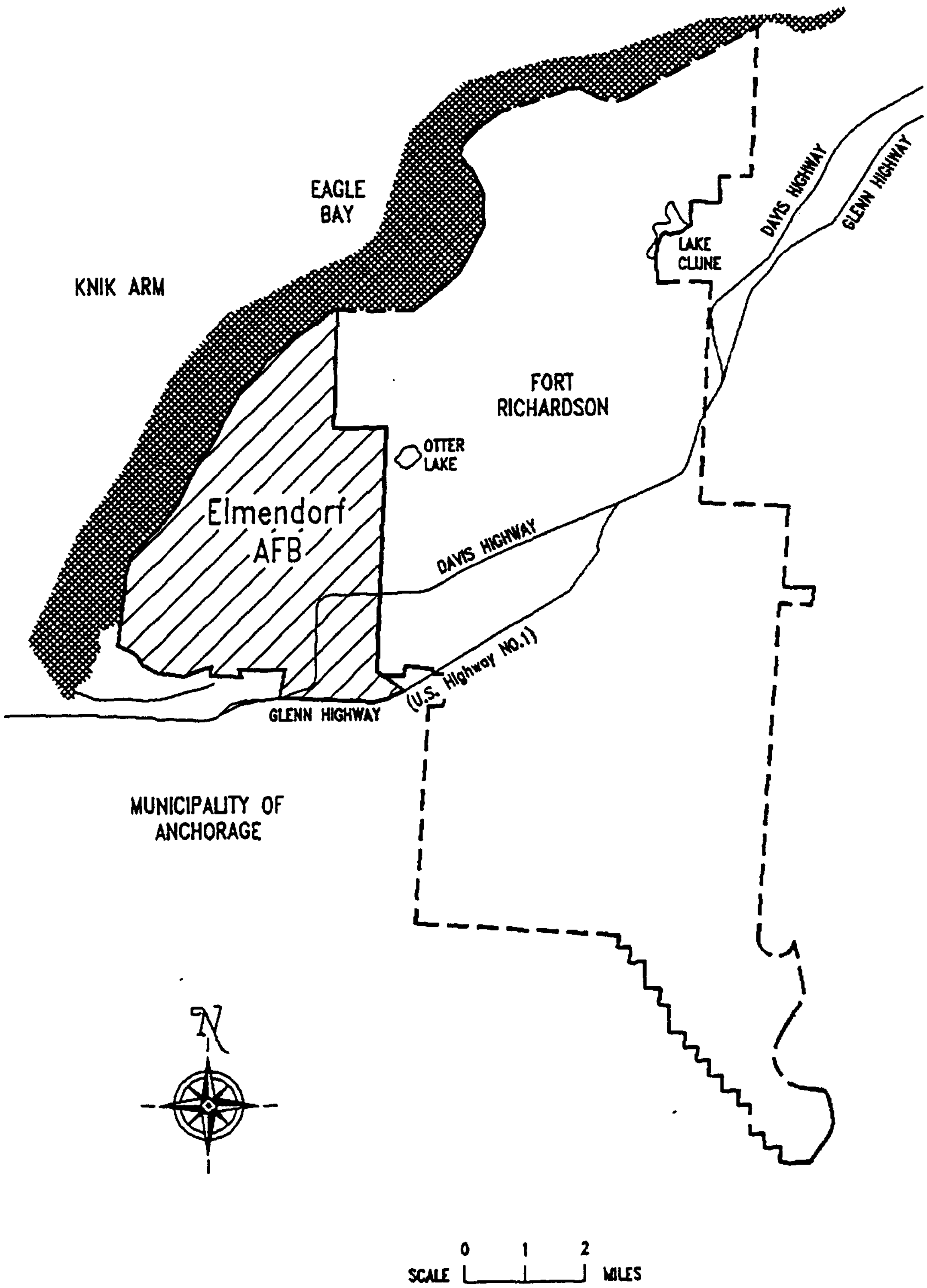
Initial construction of what is now known as Elmendorf AFB was begun in June, 1940. In the late 1940's and early 1950's, a major construction program was implemented to enlarge the base facilities and air defense forces. There was a major decline in air defense forces in the later 1950's and early 1960's. This decline stabilized in 1966 and Elmendorf returned to prominence with activation of the 21st Composite Wing (redesignated 21st Tactical Fighter Wing).

Elmendorf AFB is located within the Cook Inlet-Susitna Lowland subdivision of the Coastal Trough Physiographic Province. The base, located on 13,130 acres, is bordered on the south by the Municipality of Anchorage, on the east by the U.S. Army's Fort Richardson, and on the northeast by the Knik Arm of Cook Inlet. The regional location of Elmendorf AFB is shown on Figure 1-1, and an area location map is shown on Figure 1-2. The site plan is shown on Figure 1-3.

Prior to the mid 1940's, the extent of industrial operations and the amount of related waste generation were not significant. However, base operations since that time have generated varying quantities of wastes. The major sources of hazardous wastes include: industrial operations (shops), fire training, and fuels management. From 1945 to the present, approximately 30,000 to 52,000 gallons per year of waste oils, fuels, solvents, and cleaners were generated on Elmendorf AFB. General refuse has been disposed of on base at various landfills since

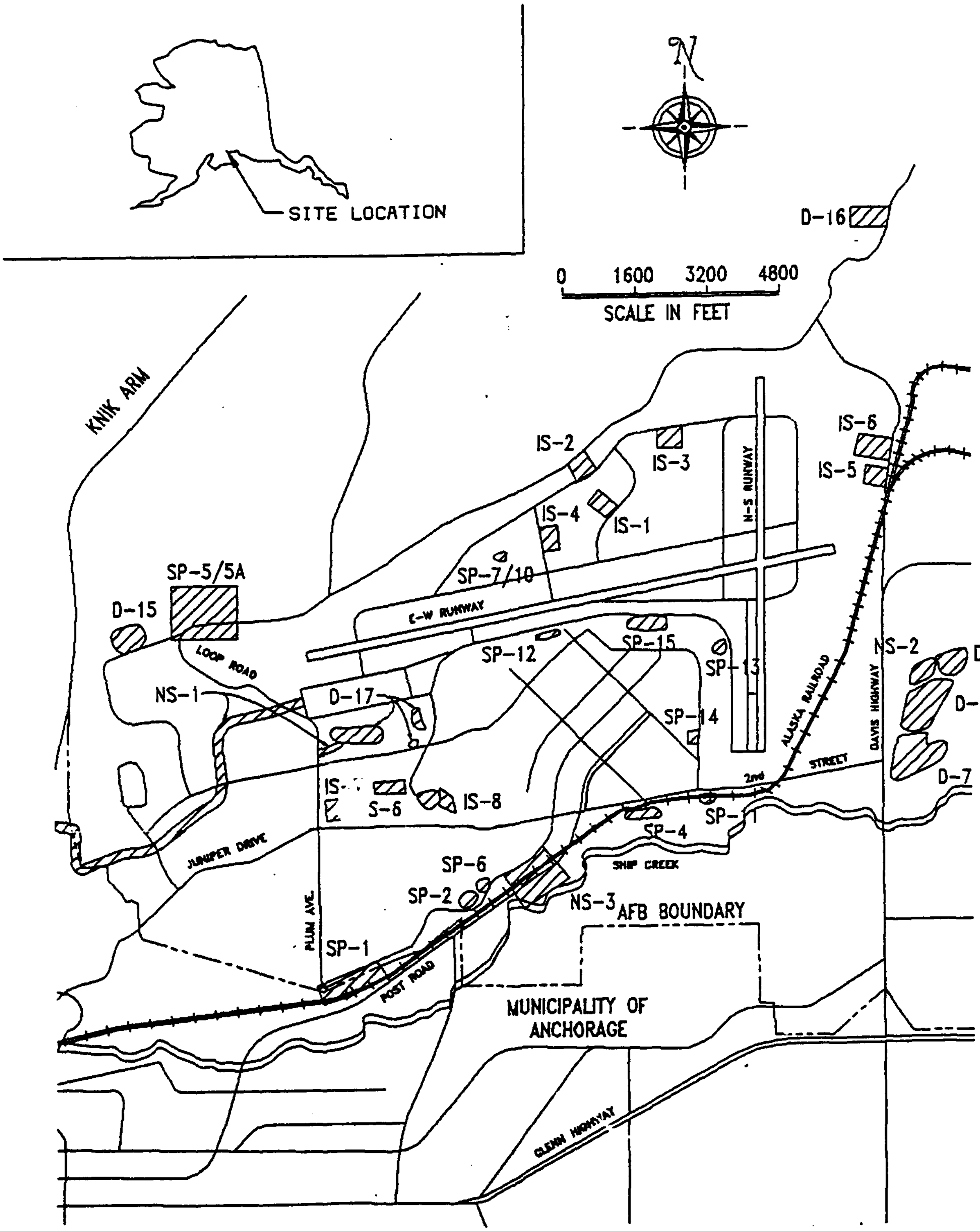
REGIONAL LOCATION
ELMENDORF AFB

FIGURE 1-1



AREA LOCATION
ELMENDORF AFB

FIGURE 1-2



SITE LOCATIONS
ELMENDORF AFB

FIGURE 1-3

the initial construction of Elmendorf AFB. A review of past and present disposal activities indicates the following:

<u>1940's - 1960's</u> - During the early period of the base operations (1940's through early 1960's) the used oils, fuels, and solvents were disposed of in several ways. Some waste chemicals, particularly solvents were drained either to the storm and sanitary sewers or to floor drains that discharged directly to dry wells beneath or adjacent to the respective facilities. Some of the waste solvents generated in various shops were disposed of directly into the surface drainage ditches. Waste oils and fuels generated in shops and along the flightline were also disposed of directly into surface drainage ditches. Combustible chemicals such as oils, fuels, and solvents were also used during this period as fuel for fire training exercises. Additionally, some waste oils were removed by contractors or spread along the unpaved roads on the base for dust control during the summer months.

<u>1960 - 1980</u> - From the mid-1960's to the late 1970's, the method for handling oils, fuels and hazardous waste entailed storing these wastes in centralized storage tanks. A principal collection point during this period was an underground tank adjacent to the old power plant (Building No. 11-433). The tank is presently locked and no longer receives any wastes. Some minor amounts of wastes were discharged to the floor drains leading either to the storm sewers, sanitary sewer or dry wells.

<u>1981 - 1989</u> - Since mid-1981, all waste chemicals have been temporarily stored at a hazardous waste storage area. The Defense Reutilization and Marketing Office (DRMO) arrange for contract disposal of these wastes. Used oils, fuels, and hydraulic fluids have been stored in a segregated manner at

central collection areas. DRMO also arranges for the contract removal of these materials. Only minor amounts of wastes, primarily generated from small spills occurring in the shop areas, still enter the floor drains of the various shop facilities. Drains are linked to the sanitary sewer, storm sewer, septic tank systems or dry wells. Building 32-060 still discharges to floor drains which lead directly to a dry well. Further investigation is needed to determine if floor drains in buildings 42-425 and 43-550 are connected to dry wells or the sanitary sewer.

1.4 DESCRIPTION OF SITES

1.4.1 Site D-3, Landfill

Site D-3 is a 15-acre landfill which was operated from 1943 to 1957. The site is located west of Hospital Drive (west of the hospital housing area), south of Oil Well Road, east of Transformer Street, and north of the sewage meter station. Site D-3 was used for disposal of general refuse and construction rubble generated from base operations. Both trench and fill and surface dump operations were used. No daily cover was applied and some open burning occurred during the 1950's; due to subsequent odor and nuisance complaints, the site was closed in 1957. Based on interviews with personnel familiar with the operations at the site, the U.S. Army disposed of spent small arms ammo (WWII) at the site, and possibly small quantities of shop wastes (Engineering-Science, 1983). The site had been closed by covering with several feet of local soil, and that it supported a substantial overgrowth of trees and brush.

1.4.2 Site D-5, Landfill

Site D-5 is approximately 17 acres in area and was used as a sanitary landfill from 1951 to 1973. The site is located on the southwestern

region of the base west of Ammo Storage area "B", east of Marketing and Redistribution and north of Ship Creek.

Trench and fill procedures were used at this site to dispose of general refuse, scrap metal, spent chemicals, and other scrap materials. The trenches were generally excavated 14 to 16 feet below grade; however, one 50-foot wide by 30-foot deep trench was reportedly excavated on the east side of the site. The exact locations of these trenches and the lateral extent of the fill are unknown, but an electromagnetic (EM) survey conducted during Phase II, Stage 2 investigation indicated that the entire 17 acres has possibly been used as a landfill at various periods of time. The majority of the landfill has been closed and is presently covered with brush, small to large trees, and grasses. The extreme northeastern end of the site has a large pile of scrap metal, including car bodies, tanks, and drums on the surface. Numerous other scattered locations had scrap metal on the surface. A clearing in the northcentral portion of the site is presently being used to dispose of scrap metal and mattresses. A gravel extraction operation is currently underway which encompasses a portion of the site including Phase II, Stage 1, Well W-2C, which is on the northern edge of the gravel pit. The pit is approximately 30 feet deep.

1.4.3 Site D-7, Sanitary Landfill

Site D-7 is a sanitary landfill which occupies approximately 35 acres and has been used for the disposal of base-generated general refuse, scrap metal, construction rubble, drums of asphalt, empty pesticide containers, and, in the 1960's, miscellaneous small quantities of shop wastes. Site D-7 is located east of Davis Road and north of Ship Creek. The landfill has been in operation since 1965. Two pits, 30 to 40 feet deep, have been operated using area fill methods. The

south pit was closed in March 1982 and covered with 2 to 4 feet of local soil and topsoil that was seeded. Borings from monitoring wells, located within the limits of the south pit fill, indicate the bottom of the fill is within 5 feet of the water table. An active area used for disposal of asbestos waste generated on Elmendorf AFB is in use in the extreme southeast portion of the site.

1.4.4 Site D-13, Disposal Site

Site D-13 was used from 1967-1971 to dispose of empty drums, metal piping, drums full of asphalt and small quantities of quicklime from base renovation operations. The material was filled into an old gravel pit. The site is east of Davis Highway and south of Marketing and Redistribution Storage. Site D-13 is approximately 2 acres in size. The site was closed with local soil cover.

1.4.5 Site D-15, POL Sludge Disposal Site No. 1

Site D-15, also identified as POL Sludge Disposal Site No. 1 is less than 1 acre in size. It is located east of Knik Arm and north of Cherry Hill Quarters. It is on the west side of the base between the bluff and the Petroleum, Oils, and Lubricants (POL) Tank Farm. Site D-15 had been used from 1964 to 1968 to dispose of sludge generated from POL tank clean outs and to weather fuel filters and pads. The site was closed with local soil cover.

1.4.6 Site D-16, POL Sludge Disposal Site No. 2

Site D-16, also identified as Sludge Disposal Site No. 2, is located northwest of Alaska Railroad, just west of Hubble Road. It is less than 1 acre is size. Site D-16 had been used from the early 1970's to 1983 for weathering fuel filters and pads on concrete slabs, and for disposing of tank clean out sludges.

1.4.7 Site D-17, Shop Waste Disposal

Site D-17 is located west of Building 31-260 and is less than 1 acre in size. It consists of a natural trench near the east-west runway used during the 1950's and 1960's as a disposal area for waste solvents, paint thinners, and other liquid wastes generated in shop operations. The waste materials were poured directly onto the permeable soil at the site. The area has been covered with soil and portions are used as a parking area for heavy equipment, while others are grass- or brush-covered.

1.4.8 Site IS-1, Building 42-400 Floor Drains

Site IS-1, Building 42-400 (Hangar No. 10) has been used for fuel loading operations. Numerous spills, up to 1,300 gallons have occurred at this facility (Dames and Moore, June 1987). In the past, most of the fuel flowed into floor drains and, hence, into dry wells at each end of the building (Engineering-Science, 1983). Currently, the floor drains discharge to oil-water separators (Ritz, USAF, personal communication, 08 March 1989).

1.4.9 Site IS-2, Building 42-425 Floor Drains

Engineering-Science (1983), in the IRP Phase I, Records Search, indicated Building 42-425 (Hangar 11) is used for aircraft maintenance, and that approximately 100 gallons per month of used solvent (PD-680) is known to have been rinsed into the floor drains. It is known that the floor drains used to discharge to dry wells (Engineering-Science, 1983) and there is no evidence to suggest that this practice has been changed.

1.4.10 Site IS-3, Building 43-550 Floor Drains

Engineering-Science (1983), in the IRP Phase I, Records Search, indicated Building 43-550 (Hangar 14) is used for helicopter maintenance and contains a helicopter washrack. Approximately 55 gallons per month of PD-680 solvent is used in the wash operations, some of which has been rinsed into the floor drains that used to lead to the dry wells (Engineering-Science, 1983). Again, there is no evidence to suggest that the floor drains do not continue to discharge to the dry wells.

1.4.11 Site IS-4, Building 42-300 Floor Drains

Engineering-Science (1983), in the IRP Phase I, Records Search, indicated Building 42-300 (Hangar 8) has been the site of aircraft cleaning with PD-680 and painting of interior aircraft parts. In the past, the floor drains in the building discharged to a dry well and probably received rinse water and minor spillage from these industrial operations. The drainage system was altered and the floor drains now discharge to an oil-water separator and then into a storm drain (Ritz, USAF, personal communication, 08 March 1989).

1.4.12 Site IS-5, Building 43-410 Floor Drains

Engineering-Science (1983), in the IRP Phase 1, Records Search, indicated Building 43-410 is used for refueling operations. It contains one washrack for ground equipment at the end of the building, and approximately 55 gallons per month of PD-680 has been regularly used in this washrack. The floor drain in the building used to discharge to a dry well. Currently, the floor drain discharges to a septic tank and leach field at the south side of the building (Ritz, USAF, personal communication, 08 March 1989).

1.4.13 Site IS-6, Building 43-450 Floor Drains

Engineering-Science (1983), in the IRP Phase I, Records, Search, indicated Building 43-450 (Hangar 15) is used for aircraft maintenance, and the primary waste entering the floor drain system would have been fuels originating from minor fuel spills. The floor drains used to discharge to a dry well. The floor drains now discharge to a septic tank and leach pits east of the building (Ritz, USAF, personal communication, 08 March 1989).

1.4.14 Site IS-7, Building 21-900 Floor Drains

Engineering-Science (1983), in the IRP Phase I, Records Search, indicated Building 21-900 is an automotive maintenance facility which is used to maintain most vehicles on base. A series of floor drains is connected to 2 sumps that used to drain into a seepage pit north of the building. Spilled petroleum products and PD-680 used in vehicle cleaning operations have been washed into the drains. Currently, the sumps discharge to a storm drain. The floor drains from the mechanical room still still discharge to the seepage pit. A catch basin on the south side of the building also runs to the seepage pit (Ritz, USAF, personal communication, 08 March 1989).

1.4.15 Site IS-8, Building 32-060 Floor Drains

Engineering-Science (1983), in the IRP Phase 1, Records Search, indicated Building 32-060 (Hangar 15) is used as the aerial delivery facility by the Aerial Port Squadron. The building houses many pieces of ground equipment. Approximately one 55-gallon drum of PD-680 is used every 3 months to clean this equipment, and some used solvent may enter the 4 floor drains that drain to a dry well adjacent to the building, which appears to be still in use (Ritz, USAF, personal communication, 08 March 1989).

1.4.16 Site S-6, PCB Transformer Storage Area

Polychlorinated biphenyl (PCB) transformers were stored at Site S-6, an old ITT facility, during the 1970's. Although a large quantity of transformers were stored on the ground at this location and leakage may have occurred, no significant transformer oil leakage has been documented. Site S-6 is located north of Nutmeg Boulevard and west of Elm Street.

1.4.17 Site SP-1, Diesel Fuel Line Leak

Site SP-1 is adjacent to 3 POL lines and was the site of a diesel fuel line leak between 1956-1958. Fuel seeped out of the ground near the railroad tracks. Thousands of gallons of diesel fuel were recovered at this location during the late 1950's but an unknown amount may have remained below ground. Site SP-1 is immediately south of the Corps of Engineers Building on a south-facing bluff above the Ship Creek flood plain.

1.4.18 Site SP-2, JP-4 Fuel Line Leak and Site SP-6, Diesel Fuel Spill, Building 22-013

Site SP-2 is located just north of the Alaska Railroad, northwest of Wilson Drive, and east of Maple Street. It is located on top of a bluff on the north side of Ship Creek. As a result of a fuel line leak, an unknown quantity of JP-4 fuel seeped out of the bank southeast of Building 22-010, near a culvert crossing Bluff Road, during 1964-1965. Periodic seeps were noted in this area throughout the 1950's and 1960's.

Site SP-6 is located north of Alaska Railroad, just west of Wilson Drive. It is located on the top of a bluff on the north side of Ship Creek. Site SP-6 was the site of an 8,000 gallon diesel fuel spill on March 31, 1976. The spill occurred during transfer of fuel from an

above-ground tank when the overflow valve failed. Collection ditches were excavated in the ice and snow to channel spilled fuel to catchment locations where it was removed by pumping into a tanker. Since the ground was frozen at the time of the spill, no appreciable fuel penetrated the subsurface and none of the fuel reached surface water.

1.4.19 Site SP-4, Railroad Maintenance Area Oil Spill

Records indicate that Site SP-4 was the site of a spill in the late 1960's. Brownish oil globs had been noticed seeping out of the bank near the railroad maintenance facility into a marsh area south of the facility and flowing into Ship Creek. It is expected that some of the oily material sank into the marsh. Site SP-4 is located north of Ship Creek, near the railroad maintenance facility in an abandoned railroad south of the airmen dorms. It is near the cooling pond on the south part of the base. The source of the oil was presumed to be the result of maintenance activities at the railroad facility.

1.4.20 Site SP-5 (and SP-5A), JP-4 Tank Spill

Site SP-5 is located north of Loop Road and west of Brown Road. Bulk Fuel Storage Tanks consisting of four 1,000,000-gallon tanks, Nos. 601 through 604, buried in the Elmendorf Moraine, have been the site of numerous spills since these aviation gasoline (AVGAS) storage tanks were installed in the early 1940's. They are interconnected and gravity fed without check valves between the tanks. A 60,000 gallon AVGAS spill occurred in the mid-1960's. On 30 August 1964, approximately 33,000 gallons of JP-4 fuel were spilled; approximately 16,000 gallons were recovered. Several million gallons of JP-4 fuel were also reportedly spilled in this area between 1973 and 1974 (Harding Lawson, 1988). Fuel from this tank system has been observed seeping from the hillside into a fuel/water separator and into the ditch adjacent to the roadway northwest of the west end of the east-west runway.

1.4.21 Sites SP-7 & SP-10, Pumphouse No. 3

Pumphouse No. 3 (Building No. 42-103) has been the site of large and small fuel spills. During 1964-1965, a 50,000 gallon JP-4 fuel spill occurred as the result of a pumphouse failure. On 27 September 1980, approximately 36,000 gallons of JP-4 was spilled onto the ground through a vent pipe due to a valve failure. Little or no fuel was recovered from either of these spills. Almost all of the fuel seeped into the gravelly soil near the pumphouse. Sites SP-7 and SP-10 are located north of the E-W runway and include Pumphouse No. 3.

1.4.22 Site SP-11, JP-4 Fuel Line Leaks

Site SP-11 is located within the Alaska Railroad boundaries at the base of the bluff bordering the Ship Creek flood plain. A JP-4 leak was discovered in 1978 along the banks of a small stream north of the base golf course and Ship Creek. An undetermined quantity of fuel was lost as a result of an underground pipe crack. Although the pipe was repaired, fuel was noted to be seeping from the bank of a small stream that flows north, through a wetland, into Ship Creek. The seeps were noted again during the 1984 drilling and sampling program.

1.4.23 Site SP-12, JP-4 Fuel Line Leak

An underground fuel line leak of approximately 1,000 gallons of JP-4 was detected at Site SP-12 in 1971. The majority of the spill was recovered, and contaminated soil was removed for disposal at the base landfill (Site D-7). The site is located near Fire Station No. 1, just south of the east-west runway, on porous gravelly till.

1.4.24 Site SP-13, Diesel Fuel Line Leak

Site SP-13 is located north of Hangar 3 and west of Taxiway 3. Records indicate that Site SP-13 was the site of a diesel fuel spill

due to a line leak in 1968. Approximately 700-800 gallons of diesel fuel seeped into the ground immediately north of the hanger building and reportedly drained into the area separating it from the adjoining hangar. None of the fuel was recovered.

1.4.25 Site SP-14, MOGAS Spill

In 1965, a 1,500 gallon motor gasoline (MOGAS) spill occurred at a former service station located near Building 11-110 at the corner of 36th Street and P Street. The spilled fuel, which seeped into the porous gravelly till, was not recovered.

1.4.26 Site SP-15, AVGAS Spill

Site SP-15 is located north of Building 11-750 between 22nd Street and 24th Street. Records indicate that Site SP-15 was the site of a 1,000 gallon AVGAS spill in 1961. Although the majority of the spill was contained and collected, some of the AVGAS seeped into the ground.

1.4.27 Site NS-1, Cherry Hill Ditch

Site NS-1 was established to investigate Cherry Hill Ditch. Cherry Hill Ditch is a drainage channel that flows westerly from the east-west runway to Cook Inlet. The headwaters of the ditch consist of a 30 inch pipe that discharges water at a rate estimated to be about 200 gallons per minute. The sources of this flow are presumed to be drains under the runway and other building drains. Occasional oily sheens and foam have been detected on water flowing through the ditch. Site NS-1 is on the west side of Elmendorf AFB. The ditch is used to channel near-surface water to the bluff above Knik Arm.

1.4.28 Site NS-2, DRMO Scrap Pile

The Defense Reutilization and Marketing Office (DRMO) scrap pile is designated as Site NS-2. Various drums are stored in the vicinity of

Site NS-2 and some surface staining of the soil has resulted. The site is east of Davis Highway and south of Marketing and Distribution. It is north of Site D-13. It is also east of Site D-5 and north of Site D-7.

1.4.29 Site NS-3, Seep No. 4, Golf Course

Site NS-3 is located south of Post Road, north of Ship Creek, and immediately north of the Golf Course Pro Shop.

It has been reported that, prior to the 1988-1989 investigations, fuel of unknown origin has appeared on the ground during the springtime in the area of NS-3, north of the golf pro shop. The fuel flowed into a drainage ditch that parallels Post Road. During 1988 and 1989 RI/FS field investigations, no fuel appeared in this area.

1.5 IDENTIFICATION AND CHARACTERIZATION OF CONTAMINATION DETECTED AT EACH SITE

Groundwater, soil, sediment, and/or surface water samples were collected at each of the 32 sites (6 of which are combined and discussed as 3 sites) to determine whether contamination existed at a site and if so the type and concentration of contamination.

Table 1-1 summarizes the contamination detected at each site during the Phase II site investigations. It should be noted that the same analytical tests were not performed at every site. The table also lists suspected contaminants, which are based on past site uses, operations, and investigation results. Suspected contaminants are listed by general categories. Petroleum hydrocarbons is a general reference to all petroleum-based hydrocarbons. Purgeable aromatics refer to more specific petroleum products, including benzene, toluene, ethylbenzene, and xylenes, often associated with fuel spills.

TABLE 1-1. CONTAMINANTS DETECTED AND RECOMMENDED ACTIONS FOR STAGE 3 IRP SITES

Site No.	Site Description	Previously Detected Contaminants: Water	Previously Detected Contaminants: Soil	Suspected Contaminants(a)
D-3	Landfill (General refuse, small amounts of hazardous wastes)	Not Previously Sampled		Halogenated hydrocarbons, metals.
D-5	Landfill (General refuse, scrap metals, spent chemicals)	Oil and Grease Trans-1,2,dichloroethene Methylene Chloride Tetrachloroethene 1,1,1-trichloroethene Trichloroethane Trichlorofluoromethane TPH	Oil and grease	Petroleum hydrocarbons, halogenated hydrocarbons, metals.
D-7	Active Landfill (General refuse, metals, pesticides containers, asphalt, shop wastes)	Oil and Grease 1,1-Dichloroethane Trans-1,2-dichloroethane Methylene Chloride Trichloroethene Trichlorofluoromethane	None detected	Halogenated hydrocarbons, metals, purgeable aromatics, petroleum hydrocarbons, pesticides.
D-13	Landfill (Drums, piping, asphalt, quicklime)	Not Previously Sampled		Petroleum hydrocarbons, metals, polynuclear aromatic hydrocarbons.
D-15	POL Sludge Disposal Site No. 1 (Tank sludge, fuel filters, fuel pads)	Not Previously Sampled		Petroleum hydrocarbons, purgeable aromatics.
D-16	POL Sludge Disposal Site No. 2 (Tank sludge, fuel filters, fuel pads)	Not Previously Sampled		Petroleum hydrocarbons, purgeable aromatics.
D-17	Shop Waste Disposal Site (Solvents, paint thinners)	1,2-Dichloroethane Trans-1,2-dichloroethene Tetrachloroethene Trichloroethene Trichlorofluoromethane Oil and Grease	Not Previously Sampled	Halogenated hydrocarbons, metals, purgeable aromatics, petroleum hydrocarbons.

(a) Suspected contaminants based on previous investigation findings and past operations.

TABLE 1-1 (Continued). CONTAMINANTS DETECTED AND RECOMMENDED ACTIONS FOR STAGE 3 IRP SITES

Site No.	Site Description	Previously Detected Contaminants: Water	Previously Detected Contaminants: Soil	Suspected Contaminants(a)
IS-1	Floor Drain at Building 42-400 (Fuel loading operations)	1,1-Dichloroethene 1,1,1-Trichloroethane Trichlorofluormethane Lead Oil and Grease	Oil and Grease	Petroleum hydrocarbons, purgeable aromatics, halogenated hydrocarbons, lead.
IS-2	Floor Drain at Building 42-425 (Aircraft maintenance)	Not Previously Sampled		Petroleum hydrocarbons, metals, purgeable aromatics, halogenated hydrocarbons.
IS-3	Floor Drain at Building 45-550 (Helicopter maintenance and wash)	Not Previously Sampled		Petroleum hydrocarbons, metals, purgeable aromatics, halogenated hydrocarbons.
IS-4	Floor Drain at Building 42-300 (Aircraft cleaning and painting)	Not Previously Sampled		Petroleum hydrocarbons, metals, purgeable aromatics, halogenated hydrocarbons.
IS-5	Floor Drain at Building 43-450 (Refueling, washing)	Not Previously Sampled		Petroleum hydrocarbons, metals, purgeable aromatics, halogenated hydrocarbons.
IS-6	Floor Drain at Building 43-450 (Aircraft maintenance)	Not Previously Sampled		Petroleum hydrocarbons, metals, purgeable aromatics, halogenated hydrocarbons.
IS-7	Floor Drain at Building 21-900 (Automotive maintenance)	Not Previously Sampled		Petroleum hydrocarbons, metals, purgeable aromatics, halogenated hydrocarbons.
IS-8	Floor Drain at Building 32-060 (Aerial delivery facility, equipment washing)	Not Previously Sampled		Petroleum hydrocarbons, metals, purgeable aromatics, halogenated hydrocarbons.
S-6	PCB Transformer Storage Area	Not Previously Sampled		PCBs.
SP-1	Diesel Fuel Line Leak	Not Previously Sampled		Petroleum hydrocarbons, purgeable aromatics.
SP-2/6	Fuel Line Leak and Diesel Line Spill	Oil and Grease	Oil and Grease	Petroleum hydrocarbons, purgeable aromatics.

(a) Suspected contaminants based on previous investigation findings and past operations.

TABLE 1-1 (Continued). CONTAMINANTS DETECTED AND RECOMMENDED ACTIONS FOR STAGE 3 IRP SITES

Site No.	Site Description	Previously Detected Contaminants: Water	Previously Detected Contaminants: Soil	Suspected Contaminants(a)
SP-4	Railroad Maintenance Area Oil Spill	Not Previously Sampled		Petroleum hydrocarbons, purgeable aromatics, halogenated hydrocarbons.
SP-5/5A	JP-4 Tank Spill	Oil and Grease	Oil and Grease	Petroleum hydrocarbons, purgeable aromatics.
SP-7/10	Pumphouse No. 3 (JP-4 spill)	Benzene, Ethylbenzene, Toluene, Xylenes, TPH, Oil and Grease	Oil and Grease	Petroleum hydrocarbons, purgeable aromatics.
SP-11	JP-4 Fuel Line Leak	Dibromochloromethane Trans-1,2-dichloroethane Tetrachloroethene Trichlorofluoromethane Petroleum Hydrocarbons Oil and Grease	Oil and Grease	Petroleum hydrocarbons, purgeable aromatics, halogenated hydrocarbons.
SP-12	JP-4 Fuel Line Leak	Petroleum Hydrocarbons Oil and Grease	Oil and Grease	Petroleum hydrocarbons, purgeable aromatics.
SP-13	Diesel Fuel Line Leak	Not Previously Sampled		Petroleum hydrocarbons, purgeable aromatics.
SP-14	MOGAS Spill	Lead Petroleum Hydrocarbons Oil and Grease	Oil and Grease	Petroleum hydrocarbons, purgeable aromatics, lead.
SP-15	AVGAS Spill	Not Previously Sampled		Petroleum hydrocarbons, purgeable aromatics, lead.
NS-1	Cherry Hill Ditch	Not Previously Sampled		Petroleum hydrocarbons, purgeable aromatics.
NS-2	DRMO Scrap Pile	Not Previously Sampled		Halogenated hydrocarbons, purgeable aromatics, petroleum hydrocarbons.
NS-3	Golf Course Seep	Not Previously Sampled		Petroleum hydrocarbons, purgeable aromatics.

(a) Suspected contaminants based on previous investigation findings and past operations.

Halogenated hydrocarbons are often associated with solvents and other by-products from industrial operations. Polynuclear aromatic compounds are often associated with the presence of coal tar pitch and, therefore, asphalt. Metals are listed as a suspected contaminant where equipment cleaning operations occurred and at landfills where scrap metal was disposed of. Lead is a specific suspected contaminant at sites where potentially leaded fuels, including AVGAS and MOGAS, were spilled. Polychlorinated biphenyls (PCBs) are listed as a suspected contaminant at site S-6. PCBs were commonly used as dielectric fluid in transformers during the time transformers were stored at S-6.

1.6 PROJECT FIELD TEAM

The field investigation was directed by Robin Hamlet (B&V), the Site Manager and principal geologist. Randy Rose (B&V) served as the Site Safety Officer. Robert Dugan and Suzanne Ban (WCC) served as geologists, and Daniel Graham (WCC) was responsible for the soil gas survey. Robert Beer (WCC) conducted the geophysical survey.

The laboratory analytical work was performed by ENSECO (Rocky Mountain Analytical Laboratory) of Arvada, Colorado under the direction of Maureen McDevitt.

Soil boring and well installation activities were performed by Discovery Drilling of Anchorage, Alaska.

Surveying was performed by LCMF, Limited of Anchorage, Alaska.

II. ENVIRONMENTAL SETTING

Several aspects of the environmental setting at Elmendorf Air Force Base (AFB) are discussed below. The land itself and how it is situated are discussed in the geographic setting and geology sections. The environmental resources of Elmendorf AFB, including water and wildlife, are discussed in the hydrogeology, natural resources, biology and ecology sections. The people of Elmendorf AFB are addressed in the cultural geography subsection as well as the cultural resources section. Two additional sections discuss air quality and climatology/meteorology.

2.1 GEOGRAPHIC SETTING

Elmendorf AFB is a roughly triangular-shaped installation located in south-central Alaska at the head of Cook Inlet (Latitude/Longitude: $61^{\circ}15'N/149^{\circ}18'W$). The base comprises 13,130 acres and extends along approximately 7.4 miles of Knik Arm (Rothe 1983). It is bordered to the north and west by Cook Inlet, to the south by the Municipality of Anchorage, and to the east by Fort Richardson Army Base.

2.1.1 Physiography (Physical Geography)

Elmendorf AFB is located within the Cook Inlet-Susitna lowland subdivision of the Coastal Trough physiographic province (Wahrhaftig 1965). The province contains glaciated areas of ground moraines, drumlin fields, eskers, and outwash plains. Most of the lowland is less than 500 feet above sea level and has a local relief of 50 to 250 feet. Rolling upland areas near the bordering mountain ranges rise to about 3,000 feet in altitude, and isolated mountains as high as 4,800 feet rise from the central part of the lowland.

The physiography at Elmendorf AFB is characterized by glacial features. The most obvious feature is the Elmendorf Moraine, a northeast-southwest trending terminal (end) moraine that transects the

base. North of the Elmendorf Moraine, the topography is characterized by smooth-surfaced elongate hills, linear valleys, and small lakes typical of ground moraines. An outwash plain characterized by a broad surface of sand and gravel parallels the Elmendorf Moraine to the south and southwest.

2.1.2 Cultural Geography

The Cook Inlet-Susitna Lowland province is the major population center of Alaska and contains most of the developed agricultural, industrial and residential lands. Elmendorf AFB is situated on the northern border of Anchorage, the largest city in Alaska. As a result of the close proximity to the city limits, the area directly south of Elmendorf AFB is generally quite developed.

The Port of Anchorage and the associated Ship Creek area are located west and south of the base. These areas have been developed for industrial use. The area parallel to Glenn Highway (south of Elmendorf AFB) is used primarily for commercial business developments, although pockets with medium- and high-density residential establishments are also present (Selkregg 1972).

Various uses of the land on Elmendorf AFB itself are detailed and inventoried in Table 2-1. The base encompasses approximately 13,130 acres. Over half of this area (7,077 acres) is essentially undeveloped, including 1,416 acres of wetlands, lakes and ponds. The remaining area, approximately 6,053 acres, has been developed for airfield operations (including runways, taxiways and maintenance buildings), base support operations, housing, and recreational facilities.

TABLE 2-1

INVENTORY OF LAND USE
ELMENDORF AFB, ALASKA

CLASSIFICATION	ACRES
Improved Grounds	
Airfield Pavements	497
Vehicle Parking	201
Lawns	2,300
Athletic Fields	80
Golf Courses	150
Parade and Drill Grounds	25
Airfield and Heliport Grounds	50
Other Improved Grounds	1,300
Semi-Improved Grounds	
Airfield and Heliport	400
Ammunition Storage*	250
Antenna Fields	200
Small Arms Ranges	30
Firebreaks**	100
Road Shoulders, Railroad Beds, Appurtenances	250
Picnic Area	20
Wildlife Foot Plots	200
Undeveloped Area	7,077
TOTAL	13,130

* Does not include unimproved area.
** Does not include forest areas.

Source: Harding Lawson, 1988.

Population and demographic characteristics for Elmendorf AFB and the surrounding areas are detailed in Table 2-2. Demographic information was acquired by the Municipality of Anchorage which generally gather information for the Municipality as a whole. The Municipality does not separate the information into geographic zones. As a result, statistics for the area within a one-mile radius of the base were not readily attainable.

The population for the City of Anchorage is approximately 210,966 (Municipality of Anchorage 1987). The 2 military establishments have a combined population of 16,386. The population at Elmendorf AFB is approximately 8,600, with most of the population centered on the developed 6,053 acres. This allows for a base population density of 1.42 persons per acre of developed land. The average age of residents of the base is 22 years, and the median household income is $16,525. Over 92 percent of the adult population have acquired a high school diploma, and 12 percent have completed 4 or more years of college. Health care and recreational facilities are provided for all military personnel at Elmendorf AFB.

2.2 GEOLOGY

The following sections discuss geological aspects of Elmendorf AFB. The geologic setting section discusses geologic events and tectonic activities that have shaped or affected the Anchorage area and Elmendorf AFB. The other sections, including bedrock geology and surficial geology, detail information concerning specific aspects of the geology.

2.2.1 Geologic Setting

Anchorage is located within the upper Cook Inlet region, a large northeast trending structural trough. The Anchorage area is bordered to the west by the Bruin Bay-Castle Mountain fault system and to the

Table 2-2

POPULATION AND DEMOGRAPHIC CHARACTERISTICS[1]

CHARACTERISTICS	MOA[3]	ELMENDORF AFB	FT. RICHARDSON
Population[2]	229,117	8,646	7,440
Racial Distribution:			
White	92.9%	78.8%	74.3%
Black	0.8%	10.7%	17.7%
Indian, Eskimo, Aleut	4.5%	1.1%	0.7%
Asian/Pacific Islander	0.7%	2.8%	2.9%
Other	1.1%	3.6%	4.4%
Age Distribution:			
Median age	26.3	22.0	21.5
Under 18 years of age	31.4%	37.4%	36.6%
Between 18 and 64	66.5%	62.4%	63.3%
Over 65 years of age	2.0%	0.2%	0.1%
Income Level (household):			
Median	$27,375	$16,525	$14,101
Per Capita	$11,339	$5,413	$4,844
Labor Force (Age: 16+)			
Civilian Labor Force	84,773	3,514	3,300
Civilian Employed	91.7%	91.8%	90.4%
Civilian Unemployed	8.3%	8.2%	9.6%
Not in Labor Force	30,368	961	979
Armed Forces	10,914	1,517	1,020
Educational Attainment:			
12 years (HS Graduate)	88.3%	92.4%	90.1%
College, 1-3 years	25.1%	27.9%	21.4%
College, 4+ years	23.6%	12.0%	16.8%
Owner/Renter Distribution			
Owner Occupied	56.5%	0.3%	0.6%
Renter Occupied	43.5%	99.7%	99.4%
Overall Vacancy Rate	13.4%	10.6%	0.0%
Number of housing units	69,845	2,303	1,720
Number of Households	60,474	2,059	1,720
Ave. Household Size	2.8	3.68	3.75

Sources: (1) U.S. Census, 1980, except for population
(2) July 1987 data provided by the Municipality of Anchorage
(3) MOA = Municipality of Anchorage

east by the Border Ranges fault system which parallels the base of the Chugach Mountains. Tectonically, the area occurs on the eastern margin of the Cook Inlet fore-arc basin.

The Cook Inlet fore-arc basin is tectonically active, resulting from subduction of the Pacific Tectonic plate beneath the North American plate. Approximately 7 percent of the annual worldwide seismic energy is released in the Gulf of Alaska-Aleutian province, and nine seismic events within the past 85 years have exceeded 8.0 on the Richter Scale (Finley et al. 1977). The fault systems bordering Anchorage (Bruin Bay-Castle Mountain system and Border Ranges system) are related to the regional subduction tectonic setting. Although most seismic events occur within the zone of underthrusting located along the Gulf of Alaska and Aleutian Islands, the likelihood of near-surface seismicity in the immediate Anchorage area is significant (Updike 1984).

Inherent in the fore-arc basin tectonic setting is volcanic activity. There are 60 volcanoes which have erupted in Alaska in the past 10,000 years and should be considered potentially eruptive (Finley et al. 1964). Twenty of these volcanoes occur along the Alaskan-Aleutian Range of which 8 have erupted since 1953. These volcanoes pose a potential hazard to the Anchorage area, although Mount Spurr with an ash fall in 1954, and Mt. Augustine with ash falls in 1976 and 1986, have been the only volcanoes to adversely affect the Anchorage area in the past 35 years.

Besides tectonic activity, Pleistocene events have greatly influenced the Anchorage area and specifically Elmendorf AFB. Included in these events are the interplay of glacial advances and retreats coupled with isostatic loading and retreat and worldwide eustatic sea level changes.

2.2.2 Bedrock Geology

Bedrock is not exposed in the Anchorage lowland and has been penetrated in only a few instances. Undifferentiated Mesozoic bedrock outcrops to the east in the Chugach Mountains and include metamorphosed sedimentary rocks, argillite, graywacke, and various volcanic bedrock. Most of these bedrock units have low primary permeability with variable secondary permeability. Tertiary deposits of the Kenai Group unconformably overlie the Mesozoic aged bedrock and form a westward thickening wedge which pinches out near the base of the Chugach Mountains. These Tertiary sediments consist of densely consolidated siltstone, sandstone, coal, shale, and conglomerates. Permeability is generally low. In the Knik Arm area, Tertiary bedrock has been penetrated at depths of 700 to 1000 feet. Within the Elmendorf AFB area, these sedimentary bedrock units occur below 300 to 400 feet.

2.2.3 Surficial Geology

Unconformably overlying the Tertiary Kenai Group is a thick nonlithofied Quaternary sequence. The Quaternary geology of the upper Cook Inlet region has been extensively studied, and the best summaries are those of Karlstrom (1964), Miller and Dobrobolny (1959), and Schmoll and Dobrovolny (1972).

Karlstrom identified 5 major glaciations, however, the last 2 glaciations, the Knik and the Naptowne, are responsible for the bulk of deposition in the Anchorage area. The Knik glaciation occurred from approximately 75,000 years to 52,000 years BP (before present) and was followed by the Naptowne glaciation lasting from approximately 48,000 years to 9,000 years BP. The 4,000 year interval between the Knik and Naptowne glaciations is represented by nonglacial deposits including peat.

Evidence of the Early Wisconsin-aged Knik glaciation include glacial outwash in the lower portion of the bluffs along the upper Knik Arm,

lateral moraines along the Chugach Mountain front, glacial deposits at Point Campbell and east of Point Woronzof, and glacial till encountered in boreholes. The Naptowne glaciation is early to late Wisconsin in age and is characterized by 2 glacial advances separated by a nonglacial interval (29,000 to 32,000 years BP). Evidence of the Naptowne glaciation includes moraines and other geomorphic features, specifically several northeast trending drumlins in east and south Anchorage. The second Naptowne glacial advance started about 29,000 years BP and reached its maximum extent at approximately 14,000 to 18,000 years BP. Included in this advance was a massive ice front that moved down into the Anchorage basin from the northwest. At times it may have entirely restricted the waterflow from the Cook Inlet region (Updike 1984). During this same glacial period, the Knik-Matanuska and Turnagain glacial arms may have coalesced within the Anchorage basin to create an ice front from the west.

The final phase of the Naptowne glaciation is characterized by ice stagnation, widespread subglacial melt-water activity and rapid stream incision. Naptowne glaciation in the immediate area of Knik Arm ended approximately 9,000 years BP (Reger and Updike 1983).

Deposition in the Anchorage basin during and immediately following the Naptowne glacial period was influenced by several geological processes and resulted in interfingering glaciofluvial, marine, and glaciodeltaic sediments. In addition, the minor advances and retreats inherent in any glacial event further complicated the sedimentological history. As a result, these processes combined to create a complex stratigraphic record.

The surficial expression of Quaternary events on Elmendorf AFB are primarily glacial in origin. The dominant feature on the base is the Elmendorf Moraine, a northeast-southwest trending terminal moraine transecting the base property. The Elmendorf Moraine was deposited during the last Naptowne retreat (approximately 12,000 years BP), and

consists of unconsolidated glacial till with poorly sorted boulders, gravel, sand and silt. South of Elmendorf Moraine are alluvial and glacial-alluvial deposits of the outwash plain. These outwash plain deposits consist of well-sorted, well-bedded gravels and sands, sometimes overlain with a thin veneer of silt. The outwash deposits exhibit good drainage characteristics and provide excellent foundation material.

The stratigraphic record of Quaternary deposits on Elmendorf AFB is more complex. Due to the close proximity of marine influences, the glacial deposits are intricately interbedded with the marine deposits of the Bootlegger Cove Formation.

The Bootlegger Cove Formation was deposited during the late stage of the Naptowne glaciation. The formation consists primarily of gray to light gray silty clay and clayey silt which is thinly bedded (1/2 to 2-inch beds). The fine-grained sediments are stiff to very stiff and generally plastic. The top of the unit is found anywhere from the surface to 120 feet below the surface of Elmendorf AFB. The base of the unit is irregular with considerable relief suggesting an erosional surface. Overall, the formation is at least 125 feet thick and may be in excess of 250 feet thick.

Updike and Carpenter (1986) described the Bootlegger Cove Formation extensively and identified seven individual facies. These facies are differentiated primarily by variations in silt and sand content and are outlined below:

- Facies I: Clay with minor silt and sand
- Facies II: Silty clay and/or clayey silt
- Facies III: Silty clay and/or clayey silt (sensitive)
- Facies IV: Silty clay and/or clayey silt containing thin silty and sand layers
- Facies V: Silty clay and/or clayey silt with random stones
- Facies VI: Silty fine sand containing silt and clay layers

Facies VII: Fine to medium sand containing traces of silt and gravel.

In addition to describing the formation, Ulery and Updike (1983) analyzed the engineering properties of the facies and mapped the units based on their cohesiveness. Facies I through Facies V comprise the cohesive unit, while Facies VI and Facies VII are noncohesive. Noncohesive sediments are generally found in west Anchorage extending from Point Woronzof south past Point Campbell. These sediments grade laterally to the east into the cohesive unit (Facies I-Facies V). At Elmendorf AFB, the Bootlegger Cove Formation is generally cohesive and consists primarily of Facies IV sediments. The fine-grained nature of these sediments inhibits drainage and makes them generally unsuitable as foundation material.

2.2.4 Soil

The following soil series are found on Elmendorf AFB. These soils were mapped by the U.S. Soil Conservation Service for the Army Corps of Engineers and the Municipality of Anchorage (USACE 1979b).

- The Caswell series consists of coarse-loamy, mixed Sideric Cryaquods. These moderately well-drained soils formed in silty and sandy waterlaid sediments over very gravelly sand. They occur on low terraces and in broad depressions. Slopes range from zero to 7 percent.
- The Purches series consists of loamy-skeletal, mixed Sideric Cryaquods. These moderately well-drained to somewhat poorly-drained soils formed in compact glacial till capped with a loess mantle. They occur in slight depressions in glacial moraines and on muskeg borders. They have slopes of zero to 12 percent.
- The Salamatof series consists of dysic Sphagnic Borofibrists. Poorly drained soils consist of deep, fibrous peat derived from sphagnum moss and sedges. They occupy

nearly level muskegs in depressions in moraines.

- The Slikok series consists of coarse-silty, mixed, acid Histic Cryaquepts. These poorly drained soils formed in deep silty sediments and occupy valley bottoms, seepage areas, and low areas bordering lakes and muskegs. Slopes range from zero to 12 percent.
- The Spenard series consists of medial over loamy, mixed Sideric Cryaquods. These soils are deep and somewhat poorly drained. They have a mottled spodic horizon developed in a loess mantle that is underlain by loamy glacial till or lacustrine deposits. They occur in drainageways, muskeg borders, and depressions in moraines. Slopes range from zero to 7 percent.
- The Torpedo Lake series consists of fine-loamy, mixed, acid Histic Cryaquepts. These poorly drained soils form in firm glacial till and occur in drainageways and seepage areas in moraines. Slopes range from zero to 20 percent.

2.3 HYDROGEOLOGY

The occurrence and movement of both groundwater and surface water are discussed in the following subsections. Groundwater occurs in shallow, unconfined aquifers as well as in confined, artesian aquifers to depths of 400 feet. Surface water is present in lakes, abundant wetlands and 2 major streams which traverse the base installation.

2.3.1 Groundwater

Various aspects of groundwater hydrology at Elmendorf AFB have been reported by Cederstrom et al. (1964), Weeks (1970), Barnwell et al. (1971), Selkregg et al. (1972), Dearborn and Barnwell (1975), Freethey (1976), Zenone and Anderson (1978), Meyer and Patrick (1980), and Freethey and Scully (1980). Additional information has been provided by the United States Geological Survey Water Resources Division and Alaska State Geological Survey personnel.

2.3.1.1 Occurrence and Movement

Two major sources of groundwater supplies have been identified at Elmendorf AFB. There is a shallow, unconfined aquifer system with four separate units, and a deeper, confined (artesian) aquifer with three distinct units. The Bootlegger Cove Formation, a near-surface marine silt and clay unit, forms the lower limit of the shallow aquifer and is the confining layer of the deeper artesian aquifer.

Water, originating as precipitation, snowmelt, or leakage through stream beds, recharges both aquifers, primarily along the Chugach Mountain front. Water in the aquifers moves downslope under the influence of gravity until it discharges to area streams, or is withdrawn by wells. Because the clay unit forms a groundwater dam where it is exposed along the coastline, the unconfined aquifer does not discharge to Cook Inlet except through Ship Creek (Weeks 1970). The shallow aquifer occurs at the surface to 50 feet below the ground surface and is expected to yield from zero to 1,500 gallons per minute (gpm). The average hydraulic gradient of this aquifer is estimated to be 20 feet per mile. The confined aquifer lies approximately 100 feet below the ground surface and is expected to yield from 5 to 1,500 gpm. The average hydraulic gradient of the confined aquifer is estimated to be 25 feet per mile (Engineering-Science 1983). The potentiometric head of the confined aquifer is variable but, due to deep groundwater extraction, generally lies below the bottom of the shallow aquifer (Dames and Moore 1987).

2.3.1.1.1 Shallow Aquifers

The shallow aquifers are composed of alluvial fan, alluvial and outwash deposits, morainal (till) deposits and tidal deposits. South of the Elmendorf Moraine, most sediments of the shallow aquifers consist of alluvial and outwash deposits. However, alluvial fan deposits occur along Ship Creek at the eastern boundary of the base installation, and tidal flat deposits are present in the coastal area

along Knik Arm. The shallow aquifers within and north of the Elmendorf Moraine consist primarily of morainal deposits and till. Major characteristics of these aquifers are summarized in Table 2-3 (Engineering-Science 1983).

The most permeable and best water-producing units are present across the southern portion of Elmendorf AFB. The least productive units are located in the northern section of the base and the bluffs overlooking Knik Arm. The north-south dividing line approximates the southern boundary of the Elmendorf Moraine (Engineering-Science 1983).

Groundwater occurs in these shallow units under unconfined conditions, although locally, shallow units may be semiconfined. Due to topographic controls and sediment variation, the depth to saturation within the individual units varies from ground surface to more than 50 feet. Typical water level depths range from 5 feet near Ship Creek to 35 feet at the closed landfill site near Building 34-018. The depth to groundwater along the heights of the Elmendorf Moraine may be on the order of 50 to 60 feet below ground surface (Engineering-Science 1983).

Shallow-aquifer groundwater flow across the southern part of Elmendorf AFB occurs in a southerly or southwesterly direction. The average hydraulic gradient within the unconfined aquifer along the southern portion of the base is 20 feet per mile (Barnwell et al. 1971). This gradient is characterized as "moderate." Insufficient information is available to discuss flow within the till units of the northern part of Elmendorf AFB (Engineering-Science 1983).

The shallow aquifer units near Ship Creek share a complex relationship. Substantial amounts of stream flow within Ship Creek, from its rise in the Chugach Mountain front to the Davis Highway (now the Glenn Highway), are lost through the alluvial fan deposits.

Table 2-3

CHARACTERISTICS OF SHALLOW AQUIFERS

Hydro-geologic	Topographic Setting	Lithology	Permeability(k) (cm/sec)	Yield Range (gpm)	Estimated Thickness (feet)
1. Alluvial Fan	Stream Valleys & Lowlands	Sand & Gravel	Very High ($K > 1 \times 10^{-1}$)	500-1500	30-100
2. Alluvial Fan and Outwash	Lowlands	Sand & Gravel	High ($K = 1 \times 10^{-1}$ to 1×10^{-2})	10-100	10-50
3. Moraine (till)	Uplands	Sand, Silt Gravel, Clay Boulder Mixture	Moderate ($K > 1 \times 10^{-2}$ to 1×10^{-3})	5-50	10-300
4. Tidal	Tidal Zone	Silt & Clay	Low (1×10^{-3} to 1×10^{-2})	Nil	50-250

Reference: Engineering-Science, 1983

However, the lower reach of Ship Creek, where it is entrenched in Bootlegger Cove Formation, gains groundwater flow. Thus, Ship Creek is both a losing and gaining system (Weeks 1970).

2.3.1.1.2 Confined Aquifers

Confined (artesian) hydrogeologic units include sand and gravel outwash deposits, alluvial sands and mixed till deposits. These units occur at moderate depths below ground surface and are typically overlain by substantial thicknesses of confining materials, such as the Bootlegger Cove Formation. Major characteristics of these units are summarized in Table 2-4.

Outwash sands and gravels which form the most prolific aquifer unit occur along the southern extent of Elmendorf AFB. Engineering-Science (1983) indicated this is the most dependable source of large quantities of groundwater and that most municipal water system wells are completed in this unit. The least productive unit is the till, common to the installation uplands.

Confined aquifer groundwater flow at Elmendorf AFB is generally in a westerly direction toward Knik Arm with a hydraulic gradient of 25 feet per mile (Engineering-Science 1983).

2.3.1.2 Groundwater Quality

Elmendorf AFB Bioenvironmental Engineering Services monitors ground water quality of the unconfined, shallow aquifers and the confined aquifer present on the base. Potential contamination problems with each aquifer-type are discussed below.

TABLE 2-4

CHARACTERISTICS OF ARTESIAN AQUIFERS

Aquifer	Topographic Setting	Lithology	Depth of Occurrence (feet)	Permeability(k) (cm/sec)	Yield Range (gpm)
1. Outwash	Lowlands	Sand & Gravel	100-300	Very High ($K > 1 \times 10^{-1}$)	200-1500
2. Alluvium	Lowlands	Sand	200-400	Moderate ($K = 1 \times 10^{-2}$ to 1×10^{-3})	200-700
3. Till	Uplands	Mixed	50-300	Variable ($K = 1 \times 10^{-1}$ to 1×10^{-7})	5-50

Reference: Engineering-Science, 1983.

2.3.1.2.1 Shallow Aquifer Contamination

Utilization of shallow aquifer units as a source of potable water supply has been limited because of contamination problems (reported in Barnwell, et al. 1971; Selkregg, et al. 1972; and Cederstrom, et al. 1964). Formerly, the City of Anchorage (now the Municipality of Anchorage) obtained 5 million gallons per day (mgd) from an infiltration gallery located at Ship Creek within city limits; however, its contamination by kerosene forced the closure of this facility. The shallow aquifer beneath the Merrill Field municipal landfill was contaminated by leachate originating from that facility. At present, public water supplies are obtained from surface waters, such as Eklutna Lake, the headwaters of Ship Creek or through large diameter, high capacity wells completed in the confined aquifer system, far below the shallow units (Engineering-Science 1983).

Engineering-Science (1983) indicated that some individual homes not served by municipal utilities obtain groundwater from small-diameter wells completed in the shallow aquifer. Other consumers using shallow aquifer-derived water supplies include isolated military facilities not connected to the central water distribution system. The primary threat to shallow aquifer water quality in this situation is posed by septic tanks serving the same home or facility. The septic system discharges to the shallow aquifer, while a short distance away a shallow well withdraws water from the same aquifer. The relatively short distances involved may not permit adequate renovation of local water quality (Selkregg, et al. 1972 in Engineering-Science 1983).

One study, reported by Dames and Moore (1985), has found shallow aquifer groundwater contamination under Elmendorf AFB that probably originated from on-Base activities This study was on the deicing drum storage area for a proposed hazardous waste storage facility. It was found that the EPA priority pollutant, 1,1-dichloroethane, had contaminated groundwater at that site.

Nelson (1982) published a detailed study of a shallow aquifer ground-water contamination problem relative to the Merrill Field municipal landfill, located south of Elmendorf AFB. He determined that while the landfill had produced leachate contaminating the shallow aquifer, the confined system was a source of good quality water supplies.

2.3.1.2.2 Confined Aquifer Contamination

Data published by Cederstrom et al. (1964), Barnwell, et al. (1971), and Selkregg et al. (1972) indicate that the quality of water obtained from the confined system is good. These waters are generally classified as calcium and magnesium bicarbonate waters of moderate hardness. Most of the water supply facilities within the Anchorage Bowl area extract water from the confined aquifer (Engineering-Science 1983).

2.3.1.3 Groundwater Uses

In general, groundwater at Elmendorf AFB serves only as a standby supply when surface water supplies cannot meet demand (Harding Lawson 1988). The area surrounding Elmendorf AFB, however, uses groundwater for various services including industrial, commercial, domestic and public supply.

2.3.1.4 Well and Pump Maintenance

Historically, there have been few problems with well and pump maintenance for wells both on Elmendorf AFB and in the surrounding area (personal communication, Mr. Jim Munter, Hydrologist IV, Alaska Department of Geological and Geophysical Surveys, 1988). The screens do not usually corrode, nor are there any problems with mineral encrustations. Once the wells are properly developed, pumping activities are relatively problem-free.

2.3.1.5 Well Inventory

An inventory of the existing wells on Elmendorf AFB and the area within a one-mile radius of the base is presented in Appendix L. Appendix L includes well completion data, water level depths and elevations, discharge data, primary well use, and ownership information. The information was provided by the United States Geological Survey Water Resources Division and was a tabulation of their file as of November, 1988. The U.S.G.S. inventory shows there are over 400 groundwater wells in the Elmendorf AFB area. The USAF owns approximately 10 percent of these wells; the U.S. Army owns about 3 percent. The balance of the wells are owned by individuals, the Municipality of Anchorage, U.S.G.S., the Alaska Department of Fish and Game, and others. Twenty-nine percent of the wells are unused; another 38 percent are used as a domestic water supply, and 13 percent are used as public water supply. Elmendorf's water supply wells are considered as public water supply wells, as are Fort Richardson's. The remainder of the wells serve various uses, including aquaculture, industrial, recreation, and fire protection uses. In addition to the inventory provided by the U.S.G.S., Appendix C presents drilling logs of monitoring wells drilled and completed during the 1988 summer field effort by Black & Veatch on Elmendorf AFB property.

2.3.2 Surface Water

Surface water is an important resource at Elmendorf AFB. Approximately 3 million gallons of surface water is used per day for base operations. These uses include water for industrial, fire fighting, hospital, and domestic utilities. Surface water occurrences at Elmendorf AFB are characterized below, and the surface water quality is also addressed.

2.3.2.1 Occurrence and Flow

Two surface water drainage basins occur within the Elmendorf AFB installation boundaries. North of the Elmendorf Moraine, most surface water drains into the Sixmile Creek basin (Engineering-Science 1983). South of the moraine, surface water generally drains south and west into Ship Creek, which is located on the southern border of the installation.

The Sixmile Creek basin occupies a valley created by an old channel of Eagle River. The creek was once a spring-fed stream, but in 1951 it was dammed. The resulting lakes, Upper and Lower Sixmile Lakes, are used as a sea- and float-plane base. The creek channel is now flooded for most of its length, although a short channel with substantial water velocity still exists below a culvert separating the 2 lakes. There is a drop of 4.8 feet between the 2 lake surfaces (Rothe 1983). Below Lower Sixmile Lake, Sixmile Creek flows west for 1.02 miles into the Knik Arm of Cook Inlet.

Ship Creek has its headwaters in the Chugach Mountains east of Anchorage, and it discharges into Knik Arm. It is approximately 24 miles long, with a drainage basin of 117 square miles. Ship Creek flows over Elmendorf AFB property for 4.2 miles between Fort Richardson and Post Road below the Elmendorf AFB fish hatchery. The lower Ship Creek basin is an important recharge area for the Anchorage confined aquifer and provides approximately 1/4 of the total recharge to the system (Weeks 1970). Table 2-5 summarizes lower Ship Creek basin stream characteristics, and Table 2-6 details discharge characteristics.

Flooding due to heavy stream runoff and tidal effects is a potential hazard along the creek boundaries, although the hazard appears to be greatest near the confluence of Ship Creek and Knik Arm (U.S. Army Corps of Engineers 1975). In general, the flow fluctuations of Ship

TABLE 2-5

LOWER SHIP CREEK BASIN STREAM CHARACTERISTICS

Drainage Area	90 square miles
Stream-course length	
Total	10.5 miles
Elmendorf	4.1 miles (21,900 feet)
Gradient	32.0 ft/mile
Latitude	61° 13' 47"
Longitude	149° 49' 44"
USGS Map	Anchorage A-8, NE Sections 9, 10, 11, NW Section 2/R3W T13N

Reference: USFWS 1983.

TABLE 2-6

SHIP CREEK DISCHARGE CHARACTERISTICS

Average Discharge	144 ft^3/second (cfs)
Mean Annual Discharge Range	91-260 cfs
Mean Annual Discharge per Unit of Area	0.002 cfs
Maximum Discharge	1,600 cfs (on 9 August 1971)
Minimum Discharge	5.8 cfs (on 14 April 1971)

Source: Elmendorf Air Force Base Gauging Station, 1970-1980 (USGS 1980).

Creek near the base are a function of groundwater interaction, precipitation, snowmelt, and diversion for municipal, military, and industrial uses (Harding Lawson 1988).

In addition to the 2 major streams and dammed lakes on Elmendorf AFB, there are approximately 7 named lakes and numerous unnamed ponds and wetland potholes. These lakes and wetland areas account for 1,416 acres on Elmendorf AFB (Harding Lawson 1988). Most of the lakes are located within close proximity to each other, either on the Elmendorf Moraine or north of it (elevations from 95 feet to 295 feet above sea level). They range in size from about 4 acres to 124 acres, and maximum depths vary from 9 feet to 28 feet. The wetland areas are generally associated with hummocky topography and also occur within, and north of, the Elmendorf Moraine.

2.3.2.2 Surface Water Quality

Surface water quality on Elmendorf AFB is monitored by the base Bioenvironmental Engineering Services group (Engineering-Science 1983). They monitor on a routine basis at 6 locations and test for 20 parameters. The 6 surface water sampling locations are shown in Figure 2-1. Samples collected from Government Hill and Ship Creek generally have been of good quality, although elevated levels of iron concentrations have been noted.

2.4 AIR QUALITY

The Municipality of Anchorage monitors the air quality for the Anchorage Bowl area. Both ambient air quality conditions and possible specific pollutants inherent to Elmendorf AFB are discussed below.

2.4.1 Ambient Quality

Elmendorf AFB is required to comply with most of the same federal air quality standards established for the entire Municipality of

Anchorage. However, there are no monitoring stations located on the base installation. The municipality has 5 monitoring stations. The locations of these stations are based on what are considered to be the areas of highest pollution potential. The station located a 7th and C Street in the downtown area is closest to Elmendorf AFB. This station monitors for particulate matter and carbon monoxide (personal communication, Mr. Steve Morris, Environmental Engineer/Air Quality Specialist I, Municipality of Anchorage, 1988). However, carbon monoxide is subject to localized variations associated with traffic patterns, and is not indicative of the air quality on the actual base property. Carbon monoxide levels and particulate matter have not exceeded the federal air quality standards for at least the last 6 months of recordings (personal communication, Mr. Steve Morris, Environmental Engineer/Air Quality Specialist I, Municipality of Anchorage 1988).

In addition to monitoring carbon monoxide and particulate matter, nitrogen dioxide and sulfur oxides are monitored at the Sullivan power plant located southeast of Elmendorf AFB. Values for these compounds have never exceeded the federal standards (personal communication, Mr. Steve Morris, Environmental Engineer/Air Quality Specialist I, Municipality of Anchorage 1988).

2.4.2 Pollution Characterization

Localized air pollutants specific to the base may include urea dust which is placed on the runways, propane which is used as a defogger and carbon monoxide which is generated with aircraft take-offs (personal communication, Mr. Bill McClarence, 1988). Elmendorf AFB is exempt from complicance with regulations of municipal auto-emission specifications (personal communication, Major Lindsey Waterhouse, Bioenvironmental Associate Engineer, Bioenvironmental Engineering Services, Elmendorf AFB 1988).

In addition to municipality regulations, the state has granted the base permits for their turbine power plants. However, plumes from the stacks of these plants have never been tested for particulates (personal communication, Mr. Bill McClarence, Environmental Field Officer/Air Quality Engineer, Alaska Department of Environmental Conservation 1988).

2.5 NATURAL RESOURCES

The broad category of natural resources may be broken down into mineral, environmental, and water resources. Mineral resources are exclusively commercially important and consist of both metallic and non-metallic materials. Environmental resources can be either commercially or recreationally important and include fish and wildlife stocks and vegetation. Both surface and subsurface water resources can also have commercial and recreational importance.

2.5.1 Mineral Resources

Metallic mineral resources are not mined on Elmendorf AFB property. Nonmetallic resources, such as sand and gravel have been extracted for construction purposes from 3 pits on the base (Rothe 1983); 1 of these gravel pits is presently active. Coal bearing sandstone and shale formations are expected at great depth beneath the installation, but have not been investigated (AEIDC 1982).

2.5.2 Environmental Resources

Fish and wildlife resources are not commercially exploited on Elmendorf AFB. Recreational hunting of small game is allowed only in certain areas on the base and is regulated by the Alaska Department of Fish and Game (ADF&G).

Fishing for trout is permitted in Ship Creek and the Sixmile Creek drainage and in Hillberg, Green, Spring, Fish, Triangle, Lower Sixmile, and Upper Sixmile Lakes. These lakes do not support natural trout reproduction but are annually stocked by ADF&G. Natural reproduction maintains large populations of rainbow trout and Dolly Varden in the Sixmile Creek drainage (Rothe 1983). Military and non-military personnel are able to use the Elmendorf AFB trout and Dolly Varden fishery in accordance with ADF&G and military regulations.

Red, silver, king, pink, and chum salmon are found in base lakes and streams (Rothe 1983). However, only red salmon are recreationally important since fishing for the other salmonid species is restricted on Elmendorf AFB (Alaska Sport Fishing Regulations 1988). Military regulations allow the taking of red salmon from below the mouth of Sixmile Creek, in Cook Inlet waters.

Vegetation influences the liveability of the base by providing soil stabilization, visual screen and noise reduction. Vegetation covers 96.5 percent of the undeveloped portion of Elmendorf AFB (Rothe 1983). Forest and woodland are the predominant cover (78 percent) of which the largest component (48 percent) is a mixed forest of birch and white spruce. Sixteen percent of the base is covered by alder and shrub community types.

2.5.3 Water Resources

Surface water resources on Elmendorf AFB are summarized in Section 2.3.2. Groundwater resources are discussed in Section 2.3.1.

2.6 CULTURAL RESOURCES

The cultural resources of Elmendorf AFB are discussed below in terms of archaeological or pre-Elmendorf resources, current cultural resources, and historical significance of the base itself.

Information concerning the archaeological resources and historical significance was extracted from the Elmendorf AFB Historical Preservation Plan (USAF 1986). Information concerning human resources was summarized from the 1987 Anchorage Population Profile (Municipality of Anchorage 1987).

2.6.1 Archaeology

Eskimos inhabited the Upper Cook Inlet region between 1100 and 1700 A.D. They were displaced by an Athapaskan people calling themselves the Denai'ua sometime between 1650 and 1780 A.D. (USAF 1986). The Denai'ua population was similar to the Tanana Indians of Interior Alaska, but much less nomadic. They lived in permanent villages and established seasonal camps for the purpose of hunting and fishing. They primarily hunted marine mammals including seals and beluga whales. Their language was regionally unique and communication with tribes from the interior or the coastal Athapaskans was, at best, difficult. Present-day populations of the Denai'ua occupy the nearby historical village of Eklutna.

Potentially important archaeological sites at Elmendorf AFB are probably restricted to the coastal bluff area and possibly the banks of Ship Creek. The early Cook Inlet people derived much of their subsistence from the sea. The bluffs overlooking Cook Inlet afforded good seasonal camp sites to watch for migrating marine mammals and salmon. The bluffs were also strategically important in the event of war. They provided a panoramic view of the inlet, which was the main avenue of approaching warriors.

One archaeological site, a fish camp, has been found along the coastal bluffs. If and when development of the bluffs continues, planning coordination must allow for proper consideration of any further potential archaeological or historical resources.

2.6.2 Human Resources

The cultural resources of the human population at Elmendorf AFB can best be characterized as a melting pot. Due to the nature of the U.S. Armed Services program, people are recruited from all of the United States. The racial distribution is in proportion to national statistics (Table 2-7).

Table 2-7 RACIAL DISTRIBUTION AT ELMENDORF AFB
(Source: Harding Lawson 1988).

Racial Distribution	Population at Elmendorf AFB (percent)	1984 U.S. Population (percent)
White	78.8	85.1
Black	10.7	12.1
Asian/Pacific Is.	2.8	
Native	1.1	
Other (including Spanish)	6.6	2.8

Another important aspect of human resources at Elmendorf AFB is the relatively young population at the base (Harding Lawson 1988). Less than 1 percent of the population is over 65 years of age. A large proportion of the population consists of young men and women with families. Children (defined as less than 18 years of age) comprise 37 percent of the base population, and the median age is 22 years.

2.6.3 Historical

On April 29, 1939 President Franklin D. Roosevelt issued Executive Order No. 8102 and withdrew approximately 45,000 acres of public land in Southcentral Alaska for use as a military reservation. By August 1940, the area was "beneficially occupied" by U.S. military troops. In December 1940, the War Department renamed this acreage Fort Richardson, placing it under the jurisdiction of the Department of the Army. It also named the flying field at Fort Richardson Elmendorf

Field after Captain Hugh M. Elmendorf, a pioneer aviator who had been killed in an accident while testing a new warplane in 1935. On March 26, 1948, the name was changed to Elmendorf Air Force Base. On March 3, 1951, the War Department transferred jurisdiction of the base from the Department of the Army to the newly created Department of the Air Force.

The development at Elmendorf AFB comprises a substantial segment of Anchorage history. The military facilities at Elmendorf AFB were instrumental in the defense of the Territory of Alaska during World War II, especially in support of the military operations in the Aleutians. Besides its military significance, the base has been an important economic factor in the development of Anchorage. With the creation of the air field in 1940 to 1941, the population of Anchorage grew rapidly after having been virtually constant for 2 decades. Elmendorf AFB continues to make a substantial contribution to the population and economy of Anchorage. The buildings identified in the Historical Resources Plan (USAF 1986) are extraordinary for their historical association. They include:

- The Quarters of the Commander-and-Chief, memorialized as the meeting place of former President Nixon and Emperor Hirohito;
- The Alaska Chateau, the VIP guest facility;
- The Major Darrel C. Pyle Building, the support headquarters of the 11th Air Force during World War II;
- The Colonel Everett S. Davis Building, in its role as Alaskan Air Command and NORAD headquarters;
- Hangar 5 as a meeting place for exceptional occasions, including the Nixon-Hirohito meetings and President Gerald Ford's address;
- The pillboxes as an incidental but fascinating aspect of World War II defense; and
- The homestead cabins.

Several of these buildings are significant due to the architectural design. The Major Darrel C. Pyle Building and the adjacent photo lab are representative of the "Neo-Georgian" architecture which was used throughout the original parts of the base. The headquarters building is particularly prominent because it formed the physical hub to which other facilities of the base were related. The officer's housing quarters are also important for their site design and characteristic architecture. The Colonel Everett S. Davis Building is a good example of Art Deco styling and the size and location of the building enable it to be identified as a landmark building. Hangars 1, 2, and 3 are primarily significant because of the engineering which made those massive structures possible. The homestead cabin is significant for the skillful and innovative pioneer construction.

2.7 BIOLOGY AND ECOLOGY

The biology of Elmendorf AFB is best characterized by observing the various communities and habitats present. The sensitivity of these habitats to disturbance and exploitation is an intrinsic part of the ecological balance of the area.

2.7.1 Communities and Habitats

A community is an association of plants and animals found in a spacially delineated area, or habitat (Ricklefs 1979). The assemblage is dominated by 1 or more prominent species or physical characteristics, which usually provide the name for the community. Most of the biological communities on Elmendorf AFB are dominated by vegetation types and are named as such (Rothe 1983). Five main communities can be identified on the base: forest-woodland, tall shrub, low shrub, sedge-grass, and aquatic. These 5 communities are described in detail hereinafter.

2.7.1.1 Forest-Woodland

Forest and woodland areas comprise 78 percent of the cover on Elmendorf AFB. Black spruce, white spruce, balsam poplar, alder, and aspen are the dominant trees found in this assemblage. The forest community on Elmendorf AFB is home to over 25 species of birds, the most abundant of which are warblers, thrushes, kinglets, woodpeckers and robins. Occasional sightings of raptors (hawks and eagles) occur on the base. Low densities of grouse and ptarmigan inhabit the forested areas. These slow-moving birds are preyed on by the raptors, and by coyotes and foxes which are predominant in this habitat.

Moose browse transects were established by Rothe (1983) to determine the quantity of browse available in a given community type. The forest habitat was calculated to be able to support 4.9 moose/km^2/day. In general, the quantity of browse was low, but quality was not deficient. Much of the original moose winter range territory on Elmendorf AFB has been destroyed by development. Less than one-quarter of the original, preferred winter range habitat remains. Moose still concentrate in the area and cause problems with housing and base operations. When moose browse is depleted on the traditional winter range, the moose are forced to other forest habitat areas where they eat all or most of the avail.ble hardwood regeneration.

Other mammals found in the forest habitat on Elmendorf AFB include small mammals and bears. Shrews, voles and squirrels seem to prefer the forested sites. Low black bear densities on Elmendorf AFB are probably related to poor habitat. Forested areas of the base provide adequate spring nutrition for the bears, but the extensive stands of fruit-producing shrubs needed to support high bear densities are lacking. However, black bear sightings have been reported in the areas around Green and Lower Sixmile Lakes, where 1 or 2 individual bears were probably seen many times.

2.7.1.2 Tall Shrub

The tall shrub assemblage is dominated by alder and comprises about 16 percent of the vegetative cover on Elmendorf AFB. Twenty-four species of bird were found in this community (Rothe 1983). Common snipes, flycatchers, and sparrows are common in the tall shrub plots, but are rare on the forested plots.

Moose are rarely found in thick stands of alder due to the lack of browse material. This type of vegetation contains compounds that inhibit digestion (Rothe 1983). Small mammals, as seen on the forested plots, are also found in tall shrub areas. Bears are not expected to be found in dense stands of alder.

2.7.1.3 Low Shrub and Sedge-grass

The low shrub and sedge-grass habitat types comprise about 1 percent of the cover on Elmendorf AFB. The types of low shrubs and grasses change with changing moisture regimes. Zones of low shrub vegetation surrounding bogs and ponds include dwarf black spruce, ericaeous shrubs and other low scrub. Wet meadows occupy small kettles (glacial ice pit depressions) and are dominated by bluejoint grass. Slightly wetter sites support growth of sedges.

Low shrub areas near wetlands are common habitat for several bird species including yellowlegs (Rothe 1983). Common snipe are abundant in the sedges and grasses of wet meadow areas.

Moose and small mammal species also use the sedge-grass assemblage. The grassy areas are heavily used by moose in spring and summer months. Meadow voles prefer the moist treeless sites with dense grass cover.

2.7.1.4 Aquatic

Lake and stream habitats on Elmendorf AFB support vegetation, fish, bird and mammal populations. The occurrence and importance of fish species in base lakes and streams is discussed in Section 2.5.2. Submerged, rooted aquatic plants are found in all base lakes. Dominant vegetation types include pond lily, water lily, pond weeds, and marestails. Sedges and cattails line the banks of most lakes and streams. Boggy areas support mosses, cotton grass, cranberry, rosemary and sedges.

Upper and Lower Sixmile Lakes are productive waterfowl areas. These lakes are shallow, and have sloping margins dominated by cattails and grasses. In comparison, Triangle and Fish Lakes are natural bog lakes having abrupt margins, deep water, little cover, and therefore are less productive waterfowl habitats. Red-necked grebes are the most abundant water bird on base. Mallard and ring-necked ducks and mew gulls are also commonly found in aquatic habitats on Elmendorf AFB (Rothe 1983). Northern water thrushes are among the last spring birds to arrive and are common in local areas around lakes and ponds. Rusty blackbirds are abundant along Sixmile Lake. Common loons are occasionally sighted in Upper Sixmile, Lower Sixmile, Hillberg, Spring, and Green Lakes.

Aquatic mammals such as beaver are common on Elmendorf AFB. Active lodges are found on Lower Sixmile Lake and Ship Creek. River otter are frequently seen in Lower Sixmile Lake. Mink are present in Otter and Upper Sixmile Lakes. Muskrats are not abundant on the base, but occasionally have been sighted.

2.7.2 Environmentally Sensitive Areas

Wetlands, lakes and streams, and moose browse areas on Elmendorf AFB can be considered as environmentally sensitive. Wetlands support

large populations of fish and birds and are particularly sensitive to pollution. The Ship Creek stream habitat on base has been subjected to channel alterations and thermal and oil pollution. These disturbances have severely degraded salmon spawning habitat and benthic macroinvertebrate populations in the creek.

Disturbance or removal of forest overstory trees encourages the growth of grasses and alders and effectively eliminates quality moose browse materials and moose over-wintering areas (see Section 2.7.1). Man-induced alder and bluejoint grass environments are easily identified in developed and disturbed areas of the base.

2.7.3 Endangered Species

None of the plant, bird, fish or mammal species found by Rothe (1983) on Elmendorf AFB have been proposed as candidates for listing as threatened or endangered species under the Endangered Species Act of 1973.

2.7.4 Economically Important Species

Economically important species do not occur naturally on Elmendorf AFB. Also, no plants or animals are raised for commercial purposes on a large-scale basis.

2.8 CLIMATOLOGY/METEOROLOGY

The principal factors affecting the climate of Elmendorf AFB include geographic position relative to large land masses and oceans, terrain and latitude.

Elmendorf AFB is situated in a transitional climatic zone between the maritime climate effects to the south and the interior or continental climate zone to the north (Selkregg 1972). The St. Elias and Chugach

Mountains to the south act as a barrier to the maritime influences of the northern Pacific Ocean, while the Alaska Range to the north protects the area from the extreme cold-air masses of the state's interior region. The close proximity of Elmendorf AFB to Cook Inlet provides additional temperate effects on the climate.

This transitional zone experiences a reasonably moderate climate, generally lacking extremes in precipitation and temperature. However, due to the northern latitudinal location of the base, annual inputs of solar radiation are reduced resulting in low mean annual temperatures.

2.8.1 Precipitation

Average annual precipitation for the Elmendorf AFB area is 15.9 inches (Leslie 1986). Most of this precipitation (9.66 inches or 61 percent of the annual precipitation) falls from June through October. Snow with minor amounts of rain is prevalent during October through April. Average snowfall during this period is 69.4 inches (5.8 inches of precipitation), which comprises 36 percent of the annual precipitation. Rainfall averages 1.49 inches during this same period. Table 2-8 presents monthly precipitation data for Elmendorf AFB collected from the period 1981 to 1984.

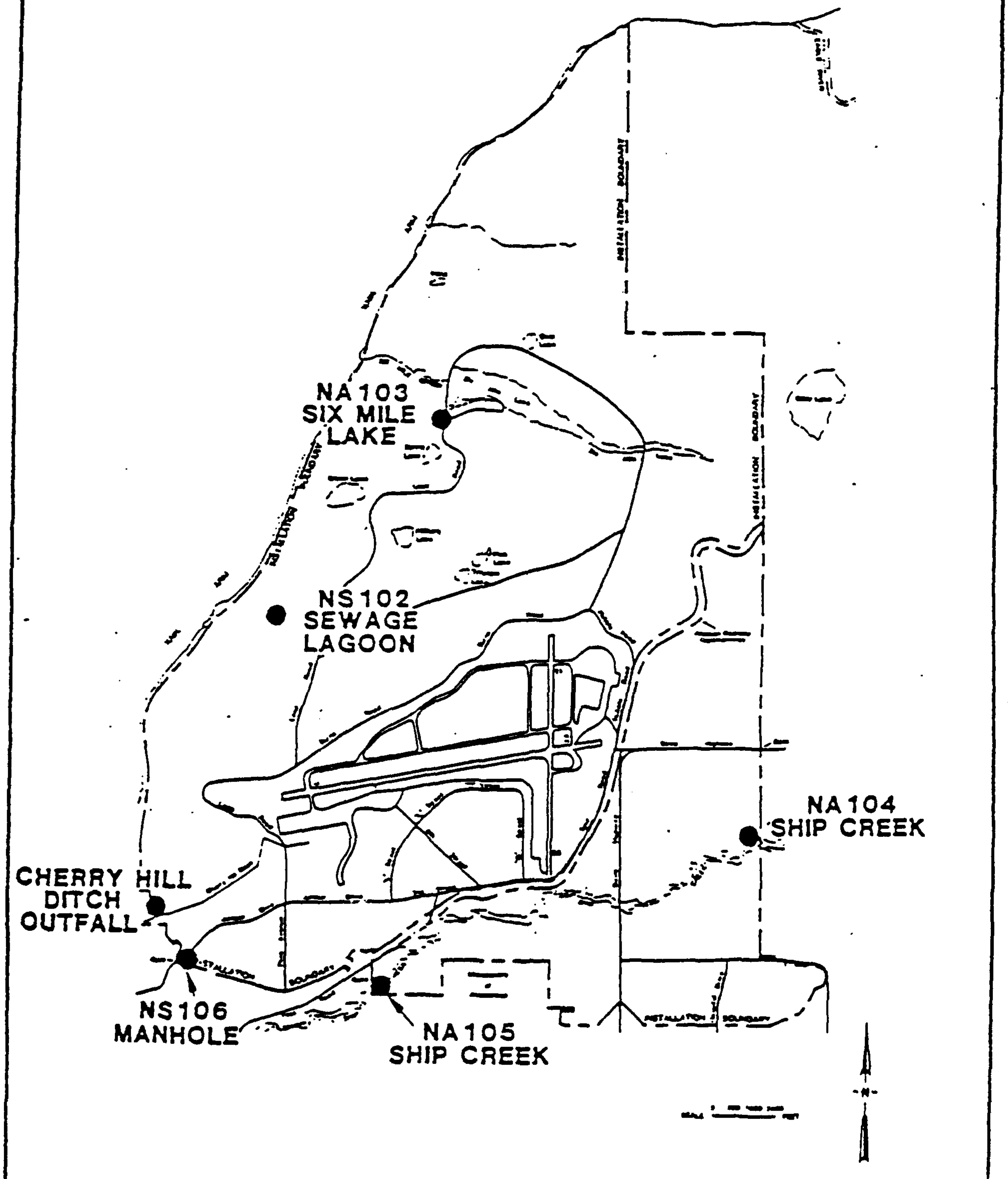
2.8.2 Temperature

Seasonal variations in temperature at Elmendorf AFB are exaggerated due to the reduced number of daylight hours during the winter months. However, daily fluctuations in temperature are relatively slight. Table 2-8 presents temperature data for the Elmendorf AFB area during the period 1941 to 1984. January exhibits the lowest monthly mean temperature at 12 F. The highest monthly mean temperature (58 F) is in July. Daily temperature fluctuations are generally 13 F to 14 F.

FIGURE 2-1

ELMENDORF AFB

BASE SURFACE WATER SAMPLING LOCATIONS



SOURCE: ELMENDORF AFB INSTALLATION DOCUMENTS

TABLE 2-8. CLIMATOLOGY SUMMARY FOR PERIOD 1941-1984
(SOURCE: LESLIE, L.D., 1986)

ELEMENDORF AFB

LATITUDE 61 15 N

LONGITUDE 149 48 W

ELEVATION 192 FEET

	TEMPERATURE (DEGREES F)												PRECIPITATION (INCHES)									
	MEANS			EXTREMES				MEAN # DAYS				HEAT DEGREE DAYS							SNOW			
								MAX		MIN						MEAN # DAYS PRECIP EXCEEDED						
MTH	MAX	MIN	MTH	REC HI	YR	REC LO	YR	70+	32-	0-	32-	MTH MEAN	MEAN MTH TOT	MAX DAY	YR	0.5	.25	0.1	MEAN MTH TOT	MAX MTH	YR	MEAN DAYS 1.0
JAN	19.1	4.8	12.0	49.0	45	-39.0	75	0.0	26.5	12.2	30.7	1636.9	0.92	1.15	65	0.3	1.3	2.9	10.2	29.0	56	31.0
FEB	24.8	9.3	17.1	50.0	43	-43.0	47	0.0	20.5	7.8	27.9	1348.0	0.92	1.70	75	0.3	0.9	3.1	11.2	31.0	56	28.0
MAR	32.0	15.9	24.0	51.0	65	-24.0	46	0.0	14.2	4.0	29.4	1256.2	0.76	1.32	79	0.3	0.6	2.6	8.7	27.0	79	28.8
APR	43.0	27.8	35.4	65.0	76	-20.0	44	0.0	2.1	0.1	22.7	878.3	0.63	0.83	63	0.1	0.6	2.3	5.4	21.0	75	12.8
MAY	54.3	38.6	46.5	80.0	47	-1.0	45	0.6	0.1	0.0	3.2	564.2	0.59	0.57	80	0.1	0.3	2.0	0.4	2.0	65	0.1
JUN	61.6	47.2	54.4	86.0	69	33.0	43	3.0	0.0	0.0	0.0	309.1	1.11	1.31	62	0.5	1.4	3.2	0.0	0.0		0.0
JUL	64.6	51.3	58.0	83.0	52	34.0	41	5.8	0.0	0.0	0.0	207.2	2.11	1.61	69	1.0	2.6	5.5	0.0	0.0		0.0
AUG	63.0	49.1	56.1	82.0	68	29.0	48	3.5	0.0	0.0	0.0	268.2	2.36	1.56	60	0.9	3.6	6.5	0.0	0.0		0.0
SEP	54.9	41.4	48.1	74.0	57	20.0	46	0.1	0.0	0.0	2.6	496.9	2.45	1.67	51	1.3	2.8	6.6	0.2	1.0	81	0.1
OCT	39.9	28.1	34.0	63.0	66	-10.0	69	0.0	5.5	0.4	20.9	966.6	1.63	1.17	52	0.6	2.1	5.1	7.6	13.0	83	7.2
NOV	27.3	14.7	21.0	57.0	47	-20.0	48	0.0	20.8	4.5	28.3	1292.2	1.13	1.31	81	0.5	1.2	3.6	10.9	19.0	56	22.0
DEC	19.8	6.6	13.2	53.0	41	-34.0	61	0.0	26.4	10.4	30.3	1590.4	1.30	1.27	55	0.3	1.7	4.4	15.4	30.0	55	28.7
	AVE	AVE	AVE	REC		REC		TOT	TOT	TOT	TOT	TOT	TOT	REC		TOT	TOT	TOT	TOT	REC		TOT
YEAR	42.0	27.9	35.0	86.0		-43.0		13.0	116.1	39.4	196.1	10814.3	15.91	1.70		6.0	19.1	47.8	70.0	31.0		158.6

Table 2-9. WIND DIRECTION BY PERCENT AT ELMENDORF AIR FORCE BASE, ALASKA (Adapted from Selkregg, L.L. et al., 1972).

Direction	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL MEAN
N	44.4	47.7	49.8	40.7	29.2	21.8	23.6	29.8	38.1	45.7	46.9	43.8	38.5
E	20.3	14.9	9.8	6.9	6.7	5.9	5.7	7.6	9.2	13.5	17.0	20.7	11.5
S	7.5	11.6	11.7	15.1	21.6	25.7	22.6	18.9	15.0	12.7	9.9	8.2	15.0
W	2.3	3.0	6.3	16.5	26.5	30.3	27.6	17.8	8.6	3.5	2.5	2.2	12.3
CALM	25.5	22.8	22.4	20.8	16.0	16.3	20.5	25.9	29.1	24.6	23.7	25.1	22.7

N = NW, NNW, N, NNE, NE
S = SE, SSE, S, SSW, SW
E = ENE, E, ESE
W = WSW, W, WNW

2.8.3 Wind

Above-surface airflow in the Elmendorf AFB area is generally towards the northeast and northwest (Table 2-9). Surface flow, however, is more variable. During the summer, surface winds blow west and northwest onto the base from Cook Inlet. In the winter, these winds are more likely to blow south along Knik Arm. Surface wind velocities average 5.8 knots (10.8 kph) although channeling of the winds near Ship Creek are common with velocities reaching 53 knots (Rothe 1983).

2.8.4 Evapotranspiration

There is no evapotranspiration information for Elmendorf AFB specifically, although evapotranspiration data have been calculated for the Anchorage Bowl area in general (Patric and Black 1968, Table 1). Using a mean annual temperature of 35.3 F and a mean annual precipitation of 14.27 inches, the potential annual evapotranspiration was calculated at 19.25 inches. The actual evapotranspiration was calculated at 15.20 inches. The difference indicates that if there were more surface water available, there would be more evapotranspiration.

Actual evapotranspiration rates are available for Palmer, Alaska which is approximately 40 miles northeast of Elmendorf AFB. Table 2-10 lists the mean monthly and seasonal evapotranspiration rates for Palmer, Alaska. There is no annual figure because evapotranspiration only occurs during the summer months in this area.

Table 2-10. MEAN MONTHLY, SEASONAL AND ANNUAL CLASS A PAN EVAPORATION IN INCHES FOR PALMER, ALASKA.

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	May-Oct *	Nov-Apr *	Other Season *	Annual *	Record Began Mo/Yr	Latest Data Mo/Yr
Palmer 61° 3', 149° 07'	-	-	-	-	5.05	4.77	4.66	3	2	-	-	-	-	-	19	-	4/69	9/78

*Sum of monthly means.

Source: NOAA, 1982.

III. FIELD INVESTIGATION PROGRAM

This section addresses the overall approach and details various aspects of the field investigation program. A basewide field investigation program was designed in the Quality Assurance Project Plan (QAPP). The field investigation program is presented for the base rather than on a site-by-site basis because the program was developed for the entire base and was similar for all sites.

3.1 ORGANIZATION AND DEVELOPMENT OF THE FIELD PROGRAM

A work plan was prepared by Harding Lawson Associates (HLA) in March 1988 for conducting the field investigation of 32 sites at Elmendorf AFB. The field program developed for the Stage 3 IRP included the tasks listed below.

- Soil gas survey.
- Geophysical investigation.
- Drilling.
- Ambient air monitoring.
- Well Construction.
- Borehole geophysical survey.
- Water level survey.
- Groundwater sampling.
- Surface water sampling.
- Soil and sediment sampling.
- Subsurface soil sampling.
- Field measurement of samples.
- Test pit excavation.
- Disposal drum sampling.
- Aquifer testing.
- Surveying of sample locations.

Each of these tasks is described briefly in this section and they are presented in greater detail in the QAPP.

3.1.1 Remedial Investigation

The field program was developed to collect data for site and waste characterization in support of the FS and to determine health and safety requirements of the field investigation team. The results of the field program are presented in detail in Section 4. Specific objectives of the field investigation program in relationship to the RI include the following:

- o Characterization of the chemical composition of the pollutants.
- o Identification and characterization of the contaminant source(s) and determination of the extent of contamination.
- o Characterization of the hydrogeology of the sites.

3.1.2 Risk Assessment

A qualitative risk assessment was completed to determine the potential risk to human health and welfare or the environment from the contaminants identified at the sites investigated. The field investigation was designed to achieve the following:

- o Identify the physical and chemical characteristics of the site contaminants.
- o Identify release mechanisms (e.g. volatilization, leaching).

- Identify potential human and environmental receptors.

- Identify potential contaminant exposure pathways.

- Determine representative rates of migration associated with individual sites.

Information on the qualitative risk assessment is presented in Sections 4.2.X.3.3 where X is numbered 1 through 22. A detailed listing of site number versus qualitative risk assessment section number is given below:

Section Number	Site Number
4.2.1.3.3	D-3
4.2.2.3.3	D-5
4.2.3.3.3	D-7
4.2.4.3.3	D-13
4.2.5.3.3	D-15
4.2.6.3.3	D-16
4.2.7.3.3	D-17
4.2.8.3.3	IS-1 to IS-8
4.2.9.3.3	S-6
4.2.10.3.3	SP-1
4.2.11.3.3	SP-2/6
4.2.12.3.3	SP-4
4.2.13.3.3	SP-7/10
4.2.14.3.3	SP-11
4.2.15.3.3	SP-12
4.2.16.3.3	SP-13
4.2.17.3.3	SP-14
4.2.18.3.3	SP-15

4.2.19.3.3	NS-1
4.2.20.3.3	SP-5/5A
4.2.21.3.3	NS-2
4.2.22.3.3	NS-3

3.1.3 Feasibility Study

The field investigation program was developed to facilitate the identification and evaluation of remedial actions for each of the sites investigated. Specific goals of the field investigation program as it relates to the FS are:

- o Develop general response actions for each medium of interest.

- o Identify volumes or areas of media to which general response actions might be applied.

- o Identify and screen the technologies applicable to each general response action medium of interest, and contaminant of concern to eliminate those that cannot be implemented technically at the site.

- o Identify and evaluate technology process options to select a representative process for each technology type retained for consideration.

3.2 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are qualitative and quantitative statements which specify the quality of the data required to support decisions during remedial response activities (EPA, 1987). DQOs are

established prior to data collection and are not considered a separate deliverable. Rather, the DQO development process is integrated with the project planning process, and the results are incorporated into the Sampling Plan, QAPP, and Work Plan (EPA, 1987). The DQO development process is broken down into three Stages as listed below:

- o Stage 1 - Identify Decision Types
- o Stage 2 - Identify Decision Uses/Needs
- o Stage 3 - Design Data Collection Program

Stage 1 tasks were completed by Harding Lawson Associates (HLA) and were included in the IRP RI/FS Stage 3 Work Plan. A portion of the DQO Stage 2 and 3 tasks were included in the Work Plan and the remainder were presented in the QAPP.

3.3 IMPLEMENTATION OF THE FIELD PROGRAM AND SUMMARY OF FIELD WORK PERFORMED

Black & Veatch was responsible for implementation and management of the field investigation program. In general the QAPP was followed during the field effort; however, there were some deviations. Sites where deviations from the QAPP occurred included FT-1, S-6, SP-5A, and D-5. Site FT-1, Fire Training Area No. 1, was deleted from the Statement of Work. Site FT-1 was investigated separately, by others, on an expedited basis. The location of Site S-6, the PCB Transformer Storage Area, was uncertain until additional data on the site was obtained. The site location as identified in the HLA Work Plan and the QAPP was incorrect. The site is located approximately 400 feet west of Elm Street and approximately 700 feet south of Acacia Drive. Investigation of Site SP-5A was added to the field program. Site SP-5A is directly south of Site SP-5 and is the location of several fuel seeps. The seeps are assumed to be related to Site SP-5. Well

W-2 on Site D-5 was to be sampled during the field effort; however, the well had been destroyed by past excavation activities and could not be sampled.

The Work Plan and QAPP indicated that 23 holes would be excavated by hand. For convenience and time savings, truck mounted drill rigs were used at 19 locations and hand augered holes were dug at the remaining 4 locations.

3.3.1 Time Sequence of Work Performed

Preparation of the Health and Safety Plan and the QAPP began on 16 May 1988 and draft Plans were submitted to AFOEHL for review in June 1988. Premobilization activities including siting well locations and obtaining drilling clearances from the base utilities groups began in May 1988. The Stage 3 field investigation for the 32 sites identified at Elmendorf AFB began on 20 June 1988. The field investigation was completed, except for the sample location and topographic survey, on 27 August 1988. This survey was conducted in October 1988. Results of the survey were available in November 1988. Sample chemical analyses were completed in November 1988. The draft Internal Technical Information Report (ITIR) was submitted for information/review in December 1988.

3.3.2 Identification and Role of Subcontractors

3.3.2.1 Woodward-Clyde Consultants

Woodward-Clyde Consultants (WCC) was the primary subcontractor for field services under this project. WCC was responsible for performing or assisting Black & Veatch in the performance of the following field related tasks:

- o Hand Auger Holes/Test Pits
- o Drilling/Soil Borings
- o Borehole Gamma Logging
- o Sediment Sampling
- o Well Installation/Development
- o Slug Tests
- o Pump Test
- o Groundwater Sampling
- o Surface Water Sampling
- o Surface Geophysical Surveys
- o Soil Gas Survey
- o Records Review
- o Field Sample Management

3.3.2.2 Discovery Drilling

Borings and monitoring wells were installed by Discovery Drilling of Anchorage, Alaska.

3.3.2.3 Enseco

Chemical analyses of field samples were performed by Enseco (Rocky Mountain Analytical Laboratory) located in Arvada, Colorado.

3.3.2.4 L.C.M.F., Limited

Surveying of all new boring and monitoring well locations for topographic and grid coordinate information was conducted by L.C.M.F., Limited of Anchorage, Alaska.

3.4 INITIAL TASKS AND INVESTIGATION SURVEYS

Initial tasks and investigative surveys included records review, site reconnaissance, geophysical surveys and soil gas surveys. These methods help define drilling locations and areas of significant volatile organic contamination. Based on these findings, conventional geotechnical and engineering exploration methods were utilized to determine subsurface conditions and obtain samples for chemical testing. Boreholes were drilled, monitoring wells were installed in many of the boreholes and developed, and water level readings were taken and slug and pump tests performed. In addition, test pits were excavated in 2 areas.

3.4.1 Geophysical Investigation

Two major types of geophysical techniques were employed: surface and borehole geophysics. The surface techniques included ground-penetrating radar, soil conductivity, and a pipe and cable locator. Borehole geophysics were made using downhole gamma-ray logging techniques.

3.4.1.1 Surface Techniques

Surface geophysical methods used included ground-penetrating radar (GPR), soil conductivity, and an underground pipe and cable locator. The techniques were used to obtain information to assist in interpretation of subsurface conditions that can affect contaminant distribution and movement, to delineate buried waste site boundaries, and to locate obstructions to the drilling. The following sections define the purpose of each technique. The field procedures for each are described, and the methods used to analyze the data are discussed.

3.4.1.1.1 Ground-Penetrating Radar

Ground-penetrating radar (GPR) was used as an aide in locating landfill boundaries and waste storage area limits at Sites D-3, D-13 and D-15. It also aided in the location of underground utilities. At Site SP-5/5A, it aided in the locating inner loop and outer loop pipelines and tank locations. The GPR technique is based on detection of differentially reflected electromagnetic energy originating from a surface source transmitted at radar frequencies. In practice, the outgoing electromagnetic pulse consists of a short pulse train. The data is recorded on a continuous strip chart as reflected signals from interfaces which appeared as a train of pulses from the reflectors, superimposed 1 above another. The instrument used in the GPR was a GSSI SIR System 3.

The GPR profiling surveys were conducted by moving two antennae across selected areas of the site. Two antennae were used separately during the investigation. The antennae were capable of transmitting signals at 80 MHz and 500 MHz. The 80 MHz signal was generally capable of penetrations to a depth of about 15 feet beneath the ground surface. The higher frequency signal effectively penetrates to a depth of about five feet with acceptable resolution of subsurface detail. The actual depth of penetration is generally limited by several factors including the soil's electrical conductivity. The presence of clay, for instance, greatly limits GPR penetration, and the presence of the groundwater table terminates GPR penetration. Soil conditions at some of the Elmendorf AFB sites allowed GPR penetration to depths as great as 25 feet due to their deep water table depths and their low number of clay lenses. Other sites contained lenses of clay, as indicated by the drilling logs, and GPR information was limited.

The data record resulting from a profiling pass resulted in an image similar to a cross-sectional view through the ground. The data record delineates features such as buried pipes and tanks. Contaminants themselves are not discernible.

GPR surveys were conducted as directed in the statement of work. GPR survey profiles as utilized in this program were limited to selected alignments on relatively flat clear ground, and used for detailed localized study.

Preliminary interpretations of the GPR data were started by post-plotting the survey line locations on a suitable scale site map. The preliminary interpretations were then made on the basis of estimated electrical conductivities for similar soils. Interpretation of the signal record was accomplished by measuring the distance from the ground surface signal trace to the top of a reflector of interest. The thickness of earthen or man-made materials overlying the reflector was calculated by using an estimated signal transit rate for the overlying materials versus measured signal return time. Verification of signal transit rates were made by comparison with known thicknesses of overlying materials whenever this information was available.

Initial test boring locations were selected on the basis of the preliminary interpretation. A final interpretation of the GPR data was performed by comparing test boring or test pit data with GPR data records at or near a common point.

An interpolation of data from test borings and GPR survey profiles was made. This information was used to interpret subsurface conditions at a surveyed site. Buried utilities, landfill boundaries and subsurface stream channels were then identified to the extent possible.

3.4.1.1.2 Soil Conductivity

Soil conductivity surveys were used to measure the differences in conductivity of soils. Soil conductivity data were read from a meter during the survey. The data were recorded, and comparative curves of soil conductivity were used to determine soil anomalies. Information derived from the soil conductivity surveys was then used to correlate the GPR data at landfill boundaries and waste storage areas at Sites

D-3, D-13 and D-15. It also was used in an attempt to identify subsurface soil layers at Sites IS-1 through IS-8 and SP-5.

The measurements were made with a Geonics EM-31 terrain conductivity meter by inducing a primary electromagnetic energy field of 9.8 kHz into the ground between a dipole transmitter and a dipole receiver spaced approximately 10 feet apart. The transmitter and receiver were mounted on a shaft which was carried along a predetermined survey route, commonly in a grid pattern with 50 feet spacings. A small alternating current is pulsed through the dipole transmitter. This electric current generates a magnetic field which in turn generates a small current in the ground. This current generates a small secondary magnetic field which is sensed by the dipole receiver. The strength of the field measured by the receiver coil is a function of the conductivity structure of the ground beneath the instrument. Thus, the lateral variations in ground conductivity can be mapped as the instrument is moved from place to place and data is recorded.

Soil conductivity surveys were conducted using equipment capable of detecting terrain conductivity differences of ± 0.1 mmhos/meter with a measurement accuracy of ± 5 percent at 20 mmhos/meter. The surveys were used to identify buried metallic objects such as pipes or cables and debris in landfills. The system was also used to distinguish soil strata to a depth of about 15 feet. The data obtained was compared to and correlated with other geophysical data and information from test borings to assist in interpretation of subsurface conditions.

Post plotting of the survey lines on a suitable scale site map allowed comparison with other data sources. The data interpretations were used to define subsurface conditions beneath the surveyed area by interpolation between survey lines and test borings.

3.4.1.1.3 Pipe and Cable Locator

A Metrotech M-480 Pipe and Cable Locator was used at Sites D-3, D-13, D-15, IS-1 through IS-8 and SP-5/5A. The pipe and cable locator is an instrument which measures conductivity. The instrument consists of a dipole transmitter and a separate dipole receiver. The transmitter is used to introduce an audio-frequency signal into a metallic conductor, such as a pipeline, through inductive or conductive coupling. The conductor simulates a large antenna and radiates this signal. Inasmuch as the acoustic signature and input signal levels are known, the signal radiation pattern can be traced using the receiver, thereby tracing the buried conductor.

The pipe and cable locator was used primarily to verify that buried cables or pipes were not located beneath proposed test boring locations. The instrument also was used to assist in interpretation of other geophysical data involving identification of buried metallic objects.

The data were obtained by monitoring a continuously recording meter during the survey. Deflections of the meter indicated changes in magnetic fields beneath the survey line. Scans were run at right angles across suspected buried objects and proposed test boring locations.

3.4.1.2 Borehole Geophysics

A Mount Sopris Model 1000-C portable geophysical borehole logger was utilized to perform the borehole surveys. The logger was equipped with a gamma sonde (detector) that measured natural gamma radiation in the soil. A total of 20 monitoring wells were logged during this field effort. These wells were drilled and completed before the logging procedure began.

The gamma sonde was attached to a cable and run through a pulley which was mounted on the well casing. This prevented the cable from touching the well casing. The cable and gamma sonde were then lowered into the well. The cable was raised at a constant rate by using a winch, while the natural gamma radiation in the soil was recorded on the borehole logger (scintillation counter).

The logging equipment was checked for scale calibration before logging each well, and at least 1 well per day was relogged as a replicate for quality control. In general, a relatively deep well was chosen for replication. This was performed to verify the consistency of the logs.

Initial equipment decontamination was accomplished by washing the cable, sonde and pulley with a high-pressure steam spray. Additional cable on the winch that may contact the well interior was also washed. Equipment was stored in unused plastic bags until ready for use. Subsequent decontamination of logging equipment was accomplished at the site of logging after a well was logged. The method consisted of washing cable and all tools in a solution of alconox and water and rinsing in HPLC water. This was followed by an additional rinse with HPLC water, a pesticide-grade methanol rinse, and a final rinse with hexane. The equipment was then allowed to air dry before using again.

3.4.2 Soil Gas Investigation

Soil gas surveys were conducted at 11 sites to delineate relative concentrations of volatile organic compounds in the soil gas. The number of probes installed at each site varied from 10 to 98 depending on the size of the individual areas and the definition required for the investigation.

The methods of soil-gas investigation used are discussed hereinafter, followed by a description of the equipment and calibration procedures used. In addition, brief descriptions of the Quality Assurance/Quality Control (QA/QC) plan and the record keeping are included.

3.4.2.1 Methods

At each soil gas survey location a 3/4-inch diameter hollow steel probe, perforated over the bottom 9 inches, was driven into the ground at various depths using an electric hammer. Negative pressure (vacuum) was applied to the probe for each sample interval (about 4 feet), and several probe volumes were evacuated for each probe with a pump. A sample was withdrawn by a gastight syringe through a septum. Within 1 to 2 minutes from the time the sample was collected it was injected into a Varian 3400 laboratory grade gas chromatograph (GC) for analysis.

This direct column injection GC method was applicable to a wide range of volatile organic compounds from low to high volatility, vapor pressure and concentration. When this method detected compounds for which reference standards were unavailable, compound identification was confirmed by at least one additional qualitative technique. A description of the Qualitative Laboratory Techniques is located in Seciton 3.4.2.2 Sampling Equipment, Analytical Equipment and Calibration Procedures.

The method detection limit (MDL) was theoretical in nature and the actual limit of quantification (LOQ) in the field varied with water content, temperature, barometric pressure, soil composition and soil electro-chemistry. The MDL was defined as the minimum concentration

of a substance measured and reported with 99 percent confidence that the value was above zero.

The direct column injection method was used to measure concentrations ranging from the MDL to 1,000 times MDL. Concentrations above 1,000 times MDL were reanalyzed, where possible, with reduced volumes or diluted samples until the peak area response was less than 1,000 times area response of the MDL peak, as determined by the chromatographic integrator.

Typical MDLs for common fuel components were: 30 ppb each for benzene, toluene and total xylenes. The actual daily MDL was affected by uncontrollable field analysis factors, such as moisture and power quality. Power quality indicates the level of electronic "noise" in the system and is from the generator. Generator load and operating condition (plugs, brushes, etc.) will effect the power quality. LOQs were established daily with the five-point calibration curve method. The calibration of the GC is discussed in Section 3.4.2.2 Sampling Equipment, Analytical Equipment and Calibration Procedure.

3.4.2.2 Sampling Equipment, Analytical Equipment and Calibration Procedures

The hollow steel probes used for sampling consisted of 3/4-inch diameter steel with 1/8-inch thick walls, perforated with symmetrical holes over the lower nine inches of the probe. Points were threaded, pressed or pinched onto the bottom of the probe. The lengths of the probes were variable. Probes were decontaminated prior to use by steam cleaning and were not reused. Probes were removed after sampling at sites where above-grade extension of the probe constituted a hazard. Probes were capped and marked with surveyors tape at sites where probes could not be removed or did not constitute a hazard.

An oilless, self-adjusting graphite-vaned vacuum pump capable of 20 inches of mercury suction at 1.5 cfm was used for sample collection. The probe vacuum heads were designed so that the sample ports were separate from the vacuum attachments.

The sampling equipment was decontaminated by purging the tubing with ambient air and then rescreening the equipment with a photoionization detection instrument. If contaminants were still present, a soap wash, followed by rinses with hexane, pesticide-grade methanol and distilled water were performed. Alternatively, the tubing was discarded and replaced with new tubing.

The analytical system included a laboratory grade GC suitable for on-column injection, a combination integrating calculator/strip chart recorder, all necessary syringes, columns, calibration and carrier gases, and an appropriate detector. The detector within the GC was a photoionization detector (PID).

Columns used were selected to obtain adequate peak separation of compounds in an acceptable time. Columns varied with the specific application. Second column confirmation was designed to resemble the original basic order or peak elution and to reach detection limits identical with the primary column.

Laboratory certified gas phase standards were used whenever possible. At least 3 volumetrically equivalent analyses were performed in order to demonstrate replicability. Field prepared standards were prepared using a solvent for dilution. Solvent peaks were independently verified. All standards were traceable to an EPA or NBS certified standard.

Ultra-pure carrier gases were used for all applications to ensure against systemic contamination problems. All plumbing fittings were checked for leaks. Use of any non-Teflon tubing, sealants or gaskets was avoided. The only non-Teflon materials used were stainless steel sampling T's. All connections to the T's were sealed with Teflon.

The qualitative GC method involved analysis by using a PID detector with a 2.6 meter stainless steel column packed with 10% SP-2100 on 100/120 Supelcoport. Ultrapure helium flowed through the isothermally (90 C) maintained column at 30 ml/min. An additional qualitative technique was added to separate BTEX compounds from unkown compounds not representative of fuels. This technique involved using the same detector and column; however, the GC was operated using different parameters. These parameters included reducing the ultrapure helium flowrate to 10 ml/min and increasing the column temperature from 50 to 130 degrees celsius over 16 minutes (20 degrees increase the first 10 minutes followed by a 60 degree increase over the next 6 minutes).

The GC was calibrated for benzene, toluene, and total xylenes with a gas-phase laboratory certified standard. The check sample consisted of a liquid-phase BTX standard. A liquid phase solvent standard for 17 solvents was also used. Not all of the solvents were detected by the method used because the columns and operating parameters were optimized for analysis of BTEX and related compounds.

The primary source of equipment contamination occurs through carryover when a high-level and low-level sample are sequentially analyzed. Therefore, to control carryover, the syringe was heated and purged with inert gas between each analysis. Whenever a high-level sample was analyzed, it was followed by an analysis of background atmosphere, standard gas or inert gas (system blank).

In addition, a daily calibration curve consisting of 5 points of various concentrations was established for each compound. One of the points was near or at the theoretical MDL. A daily MDL was calculated from the curve by extrapolation. If the curve, plotted on log-log scale paper, was linear, frequent calibration standards were injected during the day to confirm the calibration curve stability. At least 3 standards were analyzed daily in addition to the calibration curve injections.

3.4.2.3 Field QA/QC Program for Soil Gas Sampling

Quality assurance procedures for the field gas chromatography (GC) analysis included duplicate and replicate sample analysis, GC system blanks, background air sample analysis, probe blanks, and calibration standards. Total quality control analysis was not less than 20 percent of the basic sample load.

- <u>Calibration</u>: A minimum of 3 standards were used for the calibrations of field gas chromatograph.

- <u>Detection Limits</u>: The method detection limit was demonstrated through a variable number of repetitive analysis (depending on field conditions) and reported with 99 percent confidence that the value was above zero. These limits were set by utilizing the calibration procedure and assuring that the detection limit followed the calibration curve.

- <u>Blanks</u>: Method blanks consisted of helium which has been injected from a helium-filled syringe to ensure the analytical system was closed and clean. Method blanks were run at a minimum frequency of 1 every 20 samples or daily, whichever was more frequent.

- <u>Duplicates</u>: Duplicate samples were run at a minimum frequency of 1 every 10 samples or daily, whichever was more frequent. Duplicates were from the same grab sample container.
- <u>Interference Check</u>: Headspace syringes were heated and flushed with an inert gas following the analysis of a high-level sample to prevent carry-over contamination. Subsequent interference checks were run to show no contamination by target analytes.

3.4.2.4 Record Keeping

Field notebooks were maintained by assigned field personnel and contained all pertinent sampling and analytical information. In addition, a printout of the analysis (chromatographic data) was obtained. This analysis included a listing of the compounds (certified gas standards), a chromatogram, time of analysis, summary of analysis parameters, retention times and concentrations of identified compounds, and a program of sampling and pre-column/backflush analysis.

3.4.3 <u>Geotechnical and Engineering Investigation</u>

Geotechnical methods used at Elmendorf AFB included drilling boreholes, completing several of the boreholes into monitoring wells, developing the wells, performing slug tests and a pump test, and excavating observation trenches or pits. The investigative procedures for drilling borings and installing wells and developing the monitoring wells are discussed in Section 3.5. Procedures used for conducting slug tests and pump tests and excavating test pits are discussed below.

3.4.3.1 Slug Test Technique

Slug tests were conducted using a solid cylindrical piece of PVC (5 feet long by 1-1/4 inch diameter) or a piece of stainless steel (3 feet long by 1 inch diameter) connected to a new length of braided nylon twine. Twine was fastened to each slug device through a 1/2-inch diameter hole drilled near the top of each device. After decontamination with an alconox wash, followed by rinses with tap water, deionized water, methanol and hexane, the slug was rapidly lowered into the water column in the well and the water level response was measured with a 2 conductor electric water level indicator until the original water level was reestablished. After reaching the water level, the slug was withdrawn rapidly from the water column and the water level response was again measured until the well achieved its original level. The data were plotted and analyzed. If the groundwater was in an unconfined state, the data were analyzed according to the method of Bouwer and Rice (1976). If the groundwater was confined, the data were analyzed using the method of Hvorslev (1951).

3.4.3.2 Pump Test Technique

A pump test was conducted at site SP-12. The location was selected because existing data indicated that the groundwater was not contaminated, and the location was representative of the hydrogeologic conditions underlying the major developed portion of the base. Water was pumped from a 4-inch diameter PVC-cased well with a 3-horsepower submersible pump powered by a 12-kw diesel generator. Discharge of water was accomplished through a 2-inch diameter flexible hose to a point on the ground surface 240 feet northwest of the pumping well. A

discharge valve near the discharge point was used to regulate the flow rate. The flow rate was measured using an orifice tube and manometer with a calibration chart supplied by the manufacturer. The flow rate was verified by measuring the time to fill a 55-gallon drum.

Water level data were collected in three 2-inch diameter observation wells and in the pumping well with dedicated two-conductor electric water level indicators. Background-trend, drawdown, and recovery data were collected in all wells. The duration of pumping was 40.67 hours at a constant rate of 42 gallons per minute.

Hydraulic conductivity values obtained from these tests were not used to calculate travel times of contaminants due to the high values of groundwater migration rates this test provided.

3.4.3.3 Observation Trench Excavation

Two trench observation pits were excavated at Site SP-5/5A. The purpose of the trench excavation was to expose shallow soil units in order to obtain detailed soil descriptions. The specific locations for the trench excavations were selected after a visual site inspection and consultation with the Base Point of Contact (POC) (Mr. Mike Drewett). The trenches were excavated using a John Deere 301 backhoe.

The first trench was approximately 3 feet x 15 feet x 11 feet deep. The second trench was approximately 3 feet x 8 feet x 4 feet deep. The soils exposed were visually classified using the Unified Soil Classification System, and presence/absence of contamination was noted. The presence of contamination was based on stains, odors, free product, or HNu readings above background. No analytical samples were collected, and the pits were backfilled with the excavated material.

3.4.4 Surveying and Permanent Field Identification of All Sampling Locations

Surveying for each sample point was conducted by a certified land surveyor. United States Coast and Geodetic (USCG) and United States Geological Survey (USGS) bench marks were used as horizontal control and elevation reference points. Grid coordinates and the elevation of each sample location were established and are presented in Table 3-1. The information is also included on a base site map located in a pocket in this report. The surveyor notched the top of the inner riser casing for each monitoring well, and determined elevation of the notch in the pipe, and the positions of the notches were recorded on project maps. In addition to locating all boring and sample points, the surveyor also located the observation trenches at Site SP-5/5A.

Well casings and boring concrete surface caps were permanently marked with reference to the site and boring number using both paint and impact lettering. In addition, all newly installed wells were provided with locks having identical keys. A set of keys was given to the Base POC following completion of the field program.

3.5 DRILLING AND BORING PROGRAM

The drilling and well installation program as defined by the Statement of Work was followed, except where a monitoring well was scheduled, but groundwater was not encountered.

3.5.1 Number of Wells Installed and Borings Drilled

A total of 57 monitoring wells were installed at Elmendorf AFB during this Field effort. In addition 17 boreholes were drilled and subsequently backfilled. A total of 23 shallow hand augered borings were to be dug at 6 designated sites. Of these 23 shallow borings,

TABLE 3-1. SAMPLING POINT SURVEY DATA[1]

SAMPLE LOCATION	NORTH COORDINATE	EAST COORDINATE	MSL[2] ELEVATION (FT)
D3-01	2,641,583.53	543,282.68	224.08
D3-02	2,641,415.22	542,447.15	208.35
D3-03	2,640,874.85	542,108.47	205.60
D3-04	2,640,587.91	542,662.31	208.15
D13-01	2,647,880.72	541,053.91	214.85
D13-02	2,647,568.04	539,978.76	210.96
D13-03	2,646,874.26	539,796.84	207.63
D13-04	2,646,939.46	540,442.46	205.29
D15-01	2,648,595.39	522,528.95	188.99
D15-02	2,648,734.87	522,521.09	187.41
D16-01	2,658,040.08	539,455.08	274.87
D16-02	2,658,051.86	539,383.19	275.30
D16-03	2,658,175.29	539,592.95	273.29
D16-04	2,658,018.98	539,205.45	277.65
D17-01	2,646,333.37	529,073.41	154.14
D17-02	2,646,849.34	529,351.14	155.50
D17-03	2,647,287.30	529,170.92	156.14
D17-04	2,646,518.84	528,598.90	151.05
D17-05	2,646,329.66	528,023.81	148.56
D17-06	2,646,946.36	527,530.25	151.40
IS-1	2,651,785.52	533,105.08	188.23
IS-2	2,652,623.64	532,814.01	189.83
IS-3	2,652,935.05	534,944.81	202.73
IS-4	2,651,001.54	532,237.07	181.70
IS-5	2,652,204.81	539,309.33	216.09
IS-6	2,652,636.05	539,119.39	215.76
IS-7*			
IS-8	2,645,073.31	529,473.18	154.53
S6-01	2,645,611.45	528,270.52	144.80
S6-02	2,645,594.34	528,219.73	144.75
S6-03	2,645,624.35	528,328.10	144.61
S6-04	2,645,636.11	528,213.63	145.61
S6-05	2,645,652.95	528,263.91	146.51
S6-06	2,645,580.34	528,280.44	144.18
SP1-01	2,641,060.72	527,410.51	100.69
SP1-02	2,641,508.93	528,222.29	138.34

*Monitoring Well has been covered with asphalt pavement.

TABLE 3-1 (continued). SAMPLING POINT SURVEY DATA[1]

SAMPLE LOCATION	NORTH COORDINATE	EAST COORDINATE	MSL[2] ELEVATION (FT)
SP2/6-01	2,643,270.48	530,391.27	155.42
SP2/6-02	2,643,291.16	530,678.56	146.91
SP2/6-03	2,643,196.34	531,042.90	144.39
S92/6-04	2,643,044.10	530,867.20	143.21
SP2/6-05	2,642,638.11	530,414.59	138.54
SP2/6-06	2,642,737.05	530,257.73	150.47
SP2/6-07	2,643,092.91	530,379.65	151.71
SP2/6-08	2,643,018.52	530,395.57	151.04
SP2/6-09	2,643,133.52	530,438.25	155.73
SP2/6-10	2,642,988.79	530,585.93	140.83
SP4-01	2,644,617.46	534,608.14	137.36
SP4-02	2,644,632.75	534,385.14	131.27
SP4-03	2,644,972.57	534,210.28	173.67
SP5-01	2,649,412.47	524,552.52	279.97
SP5-02	2,649,401.16	524,247.13	265.52
SP5-03	2,649,556.29	524,257.14	261.57
SP5-04	2,649,513.98	524,498.63	256.81
SP5-05	2,649,607.86	524,859.61	266.28
SP5-06	2,649,377.96	524,708.31	268.86
SP5-07	2,649,164.16	524,461.17	268.43
SP5-08	2,649,838.69	524,448.07	249.79
SP5-09	2,649,409.59	524,427.83	271.99
SP5-10	2,649,832.41	524,319.42	235.14
SP5-11	2,649,340.52	524,102.68	262.20
SP5-12	2,649,388.85	523,995.41	260.30
SP5-13	2,649,638.51	524,045.48	234.40
SP5-20	2,649,841.63	524,011.32	219.09
SP5A-14	2,649,043.33	524,095.83	242.56
SP5A-15	2,649,078.58	524,299.41	252.51
SP5A-16	2,649,090.21	524,466.60	253.77
SP5A-17	2,649,112.63	524,594.19	241.21
SP5A-18	2,649,147.43	524,741.74	243.00
SP5A-19	2,649,113.90	524,875.06	236.68
SP7/10-01	2,649,762.40	531,209.09	169.28
SP7/10-02	2,649,821.84	531,512.66	170.95
SP7/10-03	2,650,591.81	531,338.03	181.46
SP7/10-04	2,650,588.76	530,874.62	177.04

TABLE 3-1 (continued). SAMPLING POINT SURVEY DATA[1]

SAMPLE LOCATION	NORTH COORDINATE	EAST COORDINATE	MSL[2] ELEVATION (FT)
SP13-01	2,648,375.84	535,691.69	185.31
SP13-02	2,648,363.00	535,779.95	185.49
SP14-01	2,646,220.91	535,382.82	181.94
SP14-02	2,645,490.34	535,396.49	181.26
SP15-01	2,648,607.87	534,348.10	185.03
SP15-02	2,648,934.93	534,520.50	184.58
NS1-01	2,646,193.38	527,106.23	139.37
NS1-02	2,647,072.35	525,723.08	141.79
NS1-03	2,645,316.63	524,862.18	128.54
NS1-04	2,643,895.66	522,805.63	106.76
NS2-01	2,648,113.78	540,716.44	211.34
NS2-02	2,647,807.69	540,044.44	210.76
NS3-01	2,644,365.00	534,129.18	126.12
NS3-02	2,643,844.94	533,549.90	121.13
NS3-03	2,643,388.95	532,258.09	111.92
NS3-04	2,644,108.79	531,896.10	149.25
NS3-05	2,644,092.46	532,225.52	136.84
NS3-06	2,644,389.33	532,813.91	149.03
SC-4	2,644,183.95	534,143.52	121.11
SC-5	2,642,986.00	532,141.85	104.04
SC-6	2,642,743.12	531,239.76	98.99
BH-01	2,650,891.03	541,394.13	230.34
BH-02	2,655,537.28	538,119.94	248.90
BH-03	2,656,448.04	534,545.68	318.27
BH-04	2,652,367.93	528,949.22	303.19
BH-05	2,651,407.02	526,682.84	245.08
BH-06	2,646,452.06	525,258.31	145.38
PT-01	2,648,328.09	532,279.44	176.60
PT-02	2,652,536.33	530,730.73	157.77
PT-03	2,648,317.94	532,268.46	176.50
PT-04	2,648,275.21	532,220.05	176.17

TABLE 3-1 (continued). SAMPLING POINT SURVEY DATA[1]

SAMPLE LOCATION	NORTH COORDINATE	EAST COORDINATE	MSL[2] ELEVATION (FT)
Upper Trench	2,649,086.69	524,432.20	251.90
Lower Trench	2,649,039.38	524,461.09	229.30

(1) THE COORDINATES LISTED ABOVE ARE ALASKA STATE PLANE COORDINATES, ZONE 4. THE BASIS OF THESE COORDINATES IS THE USC & GS STATION "TT AN 7 USE" WHICH IS THE POINT OF ORIGIN FOR THE ELMENDORF COORDINATE SYSTEM AT 110,000 NORTH AND 110,000 EAST. THE THEATA ANGLE AT THIS STATION IS +0°10'03" AND THE SCALE FACTOR IS 0.9999013.

(2) MEAN SEA LEVEL.

19 were drilled with a truck mounted drill rig and only 4 were dug by hand. Two observation trenches were excavated at Site SP-5/5A. Table 3-2 indicates the number of monitoring wells and borings or hand augered borings at each Site.

3.5.2 Footage Summary

Total footage drilled or excavated at Elmendorf AFB under this program exceeded 3,000 lineal feet. Table 3-3 summarizes the footage drilled for each monitoring well or boring type for each Site.

3.5.3 Drill Rigs and Drilling Techniques

Test borings and monitoring wells were drilled using either a CME-55 or CME-75 truck-mounted drill rigs. Due to the swampy conditions at boring location SP5-20, this well was drilled using a CME-55 drill rig on a track-mounted Nodwell. All shallow soil augering was done with either the truck-mounted drill rigs or, where access was a problem, a manual post-hole digger. All drill rigs were diesel powered.

Test borings and boreholes for monitoring wells were drilled with helical, hollow stem flight augers with hard-faced carbide bits. Except for the shallow soil augerings, or locations where the groundwater table was encountered at a shallow depth, all boreholes were drilled to a depth of at least 25 feet. Section 3.5.2 provides a summary of footage drilled at Elmendorf AFB, and a complete set of the boring logs is included in Appendix C.

Following the completion of drilling and acquisition of all soil samples and groundwater measurements (see Section 3.5.5), the hole was either completed as a monitoring well or backfilled with a volclay slurry and a cap of cement was placed in the upper 1 foot. This

TABLE 3-2
ELMENDORF DRILLING AND BOREHOLE PROGRAM
IRP STAGE 3

SITE NO.	TOTAL NO. WELLS	TOTAL NO. BORE-HOLES	TOTAL NO. HAND AUGER	TOTAL NO. TEST PITS
D-3	3	1	0	0
D-13	3	1	0	0
D-15	0	0	2	0
D-16	0	4	0	0
D-17	0	6	0	0
IS-1 to IS-8	8	0	0	0
S-6	0	6	0	0
SP-1	2	0	0	0
SP-2/6	5	5	0	0
SP-4	3	0	0	0
SP-5	7	5	2	2
SP-5A	4	2	0	0
SP-7/10	4	0	0	0
SP-13	0	2	0	0
SP-14	2	0	0	0
SP-15	2	0	0	0
NS-2	2	0	0	0
NS-3	3	3	0	0
BASE HYDRO	5	1	0	0
PUMP TEST	4	0	0	0
BASE-WIDE	57	36	4	2

TABLE 3-3
TOTAL DEPTH OF DRILLING-IRP STAGE 3

SITE NO.	BORING NO.	TYPE	DEPTH	TOTAL SITE FOOTAGE
D-3	D3-01	MONITOR WELL	61.5	
	D3-02	MONITOR WELL	31	
	D3-03	MONITOR WELL	20	
	D3-04	BOREHOLE	60	
				172.5
D-13	D13-01	MONITOR WELL	55	
	D13-02	MONITOR WELL	46	
	D13-03	MONITOR WELL	50	
	D13-04	BOREHOLE	60	
				211
D-15	D15-01	HAND AUGER	5	
	D15-02	HAND AUGER	5	
				10
D-16	D16-01	BOREHOLE (1)	5	
	D16-02	BOREHOLE (1)	5	
	D16-03	BOREHOLE (1)	5	
	D16-04	BOREHOLE (1)	5	
				20
D-17	D17-01	BOREHOLE (1)	5	
	D17-02	BOREHOLE (1)	5	
	D17-03	BOREHOLE (1)	5	
	D17-04	BOREHOLE (1)	5	
	D17-05	BOREHOLE (1)	5	
	D17-06	BOREHOLE (1)	5	
				30
IS	IS-1	MONITOR WELL	35	
	IS-2	MONITOR WELL	40	
	IS-3	MONITOR WELL	50	
	IS-4	MONITOR WELL	30	
	IS-5	MONITOR WELL	60.5	
	IS-6	MONITOR WELL	60	
	IS-7	MONITOR WELL	27	
	IS-8	MONITOR WELL	35	
				337.5
S-6	S6-01	BOREHOLE (1)	5	
	S6-02	BOREHOLE (1)	5	
	S6-03	BOREHOLE (1)	5	
	S6-04	BOREHOLE (1)	5	
	S6-05	BOREHOLE (1)	5	
	S6-06	BOREHOLE (1)	5	
				30

(1) Identified as a hand auger hole in the QAPP.

TABLE 3-3
TOTAL DEPTH OF DRILLING-IRP STAGE 3

SITE NO.	BORING NO.	TYPE	DEPTH	TOTAL SITE FOOTAGE
SP-1	SP1-01	MONITOR WELL	20	
	SP1-02	MONITOR WELL	50	
				70
SP-2/6	SP2/6-01	MONITOR WELL	50	
	SP2/6-02	MONITOR WELL	51.5	
	SP2/6-03	MONITOR WELL	52.5	
	SP2/6-04	MONITOR WELL	53	
	SP2/6-05	MONITOR WELL	46	
	SP2/6-06	BOREHOLE	51.5	
	SP2/6-07	BOREHOLE	50	
	SP2/6-08	BOREHOLE	50	
	SP2/6-09	BOREHOLE	51.5	
	SP2/6-10	BOREHOLE	40	
				496.5
SP-4	SP4-01	MONITOR WELL	26.5	
	SP4-02	MONITOR WELL	26.5	
	SP4-03	MONITOR WELL	55	
				108
SP-5	SP5-01	MONITOR WELL	46.5	
	SP5-02	MONITOR WELL	36.5	
	SP5-03	BOREHOLE	51.5	
	SP5-04	BOREHOLE	61.5	
	SP5-05	BOREHOLE	51.5	
	SP5-06	MONITOR WELL	48	
	SP5-07	MONITOR WELL	56.5	
	SP5-08	MONITOR WELL	26.5	
	SP5-09	BOREHOLE	41.5	
	SP5-10	MONITOR WELL	15	
	SP5-11	HAND AUGER	5	
	SP5-12	BOREHOLE (1)	5	
	SP5-13	HAND AUGER	5	
	SP5-20	MONITOR WELL	8	
	PIT 1	TRENCH	11	
	PIT 2	TRENCH	4	
				473
SP-5A	SP5A-14	BOREHOLE	25	
	SP5A-15	MONITOR WELL	21.5	
	SP5A-16	MONITOR WELL	20	
	SP5A-17	BOREHOLE	28	
	SP5A-18	MONITOR WELL	18	
	SP5A-19	MONITOR WELL	20	
				132.5

(1) Identified as a hand auger hole in the QAPP.

TABLE 3-3
TOTAL DEPTH OF DRILLING-IRP STAGE 3

SITE NO.	BORING NO.	TYPE	DEPTH	TOTAL SITE FOOTAGE
SP-7/10	SP7/10-01	MONITOR WELL	35	
	SP7/10-02	MONITOR WELL	25	
	SP7/10-03	MONITOR WELL	30	
	SP7/10-04	MONITOR WELL	30	
				120
SP-13	SP13-01	BOREHOLE (1)	5	
	SP13-02	BOREHOLE (1)	5	
				10
SP-14	SP14-01	MONITOR WELL	40	
	SP14-02	MONITOR WELL	45	
				85
SP15	SP15-01	MONITOR WELL	39	
	SP15-02	MONITOR WELL	40	
				79
NS-2	NS2-01	MONITOR WELL	56.5	
	NS2-02	MONITOR WELL	55	
				111.5
NS-3	NS3-01	BOREHOLE	26.5	
	NS3-02	MONITOR WELL	26.5	
	NS3-03	MONITOR WELL	14	
	NS3-04	BOREHOLE	26.5	
	NS3-05	BOREHOLE	26.5	
	NS3-06	MONITOR WELL	42	
				162
BASE HYDRO	BH-01	MONITOR WELL	65	
	BH-02	BOREHOLE	60	
	BH-03	MONITOR WELL	40.6	
	BH-04	MONITOR WELL	18	
	BH-05	MONITOR WELL	17	
	BH-06	MONITOR WELL	10.5	
				211.1
PUMP TEST	PT-01	OBSERV. WELL	42	
	PT-02	OBSERV. WELL	26.5	
	PT-03	OBSERV. WELL	40	
	PT-04	OBSERV. WELL	78	
				186.5
BASE-WIDE TOTALS				3056.1

(1) Identified as a hand auger hole in the QAPP.

procedure was to ensure that the borehole was sealed and future migration of contaminants or infiltration of water was minimized. Uncontaminated soil cuttings were left on site. Drill cuttings that exhibited a potential to be contaminated (i.e., through visual observation or instrument screening) were containerized in 55 gallon drums; stored in the yard of Building 22-009; and sampled to assist in determining their ultimate disposition.

3.5.4 Well Design and Installation Details

Following drilling, monitoring wells were installed. Two-inch ID PVC screens with up to 0.020-inch slots were used for wells at Elmendorf AFB. Each well screen was a minimum of 10 feet and a maximum of 20 feet in length, with a PVC cap at the bottom of the screen. The screen was located in each borehole to monitor at least 8 feet below and 2 feet above the existing static water level. This allowed for the collection of floating contaminants (if present) and the measurement of the water table and allows for a 2 foot seasonal fluctuation of the water table. Blank sections of PVC riser pipe were added so the well extended 2 feet to 3 feet above the ground surface. Several wells were completed flush with the land surface due to the high traffic nature of the site or proximity to the runway and aprons.

A sand pack was placed around the PVC screen by filling the well annulus with washed, rounded silica sand with a grain size compatible with the screen slot size. The sand was poured directly into the borehole around the PVC pipe. Soundings were taken periodically to check the actual height of the sand fill versus the anticipated height, based on the volume of sand introduced. This method was used to assure the sand pack was not bridged. The sand pack extended from the bottom of the borehole to a level 2 feet above the top of the

screen. Bentonite pellets, which formed a 5 foot seal, were placed above the sand pack, and a volclay slurry filled the remaining annulus space of the hole to within 2 feet of ground level. These materials were introduced and checked in the same manner as the sand pack. The upper 2 feet of the well was capped with cement. A typical monitoring well installation for an above ground completion is presented on Figure 3-1. Well Completion Forms, which were filled out by drilling personnel, are provided in Appendix C. The forms depict the actual installation for each monitoring well.

Monitoring wells completed with above ground risers have a 6-inch ID steel protective casing placed over the PVC pipe seated in a 2-foot by 2-foot by 4-inch concrete surface pad. The protective casing was placed 2 feet into the hole and was topped by a locking steel cap. Flush-mount wells were completed by cutting the PVC pipe to a point 2 to 3 inches below the land surface. A locking cast aluminum or cast iron protective valve box was fitted around the PVC pipe. The assembly was cemented into a 3-foot diameter concrete pad. A typical flush-mount completion is shown in Figure 3-2.

3.5.5 Field Measurements and Data Acquisition

Split spoon samples of the soil were collected at 5-foot intervals from all drilled borings and scanned for volatile organic compounds (VOCs) using an HNu photoionization meter (HNu). Materials were visually classified according to the Unified Soil Classification System. Water level measurements were attempted at the first sign of very damp or wet soil. Water level was also measured at the completion of drilling and again after well construction and development.

Boring logs were made for each boring and monitoring well installation. These logs contain general information about the boring

such as boring number, date started and completed, driller's code, logger's code, and borehole depth and diameter. In addition, specific information concerning sample method, soil sample depth intervals, sample recovery, material recovered, sample class/code and sample identification is included. Results of all field measurements including water level, HNu readings, temperature, and the presence/absence of visual contamination and odor are also recorded on the logs. HNu readings below 5 ppm are generally considered background levels; however, all HNu readings were recorded as read in the field.

3.6 SAMPLING PROGRAM FOR AIR, WATER, AND SOIL/SEDIMENT

The purpose of the 1988 sampling program at Elmendorf AFB was to obtain information which can be utilized in further characterizing the sites of concern. To achieve this goal, several media were sampled. Initial sampling consisted of soil gas surveys (Section 3.4.2) performed at selected sites to delineate areas of significant volatile organic contamination. Borings were then drilled and soil samples were collected for laboratory analysis. Groundwater monitoring wells were constructed, developed, and sampled, and the groundwater samples were analyzed at the laboratory. Surface water and surface sediments were also sampled in selected locations.

Although the air was monitored during the drilling of each borehole, air samples were not collected for analysis.

3.6.1 Types and Numbers of Samples

Six types of samples were obtained during the Stage 3 field investigation. These sample types were soil, sediment, groundwater, surface water, containerized material, and soil gas. Table 3-4 provides a detailed list of the number and type of samples collected at each site.

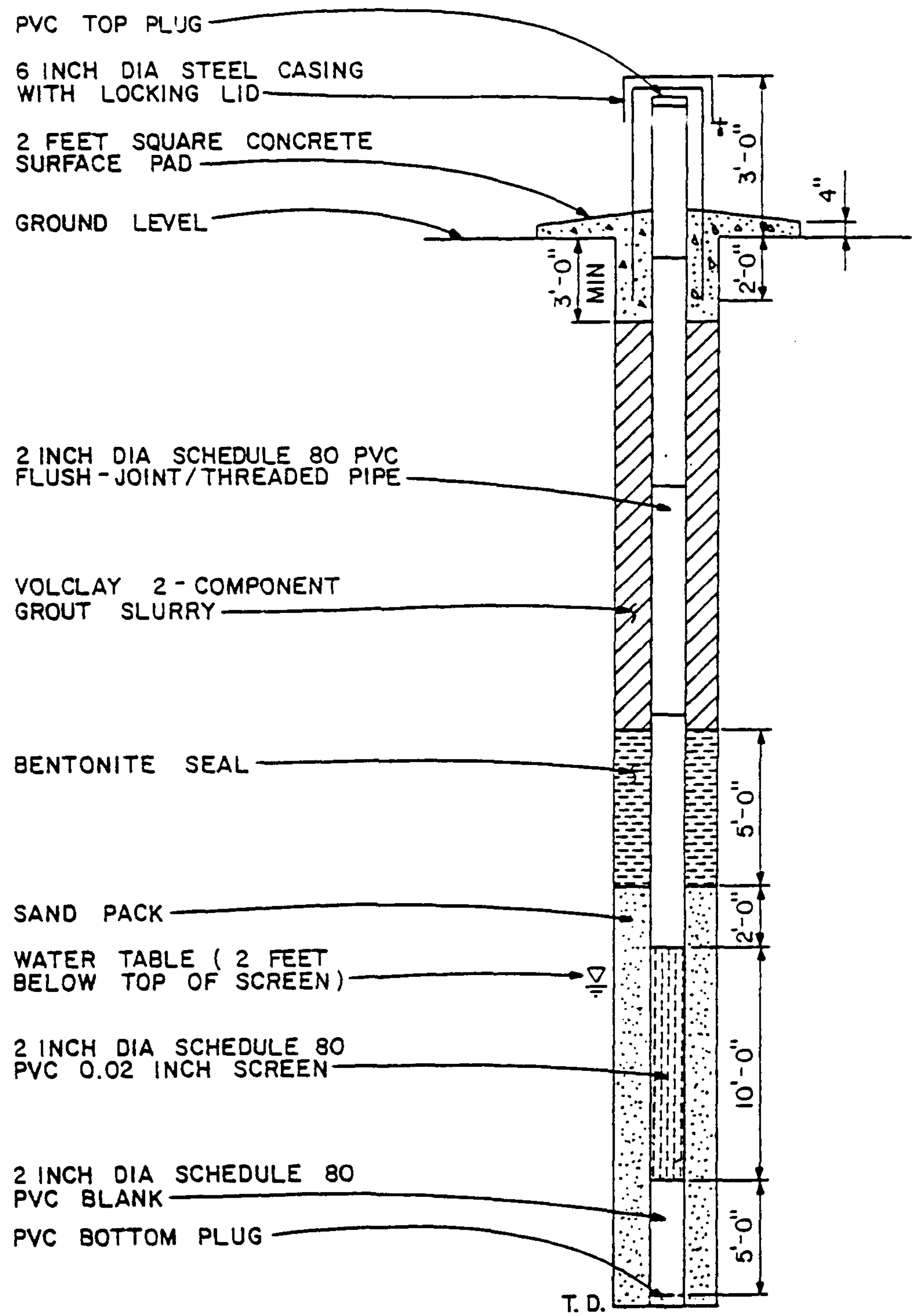


FIGURE 3-1
ABOVE-GRADE COMPLETION MONITORING WELL CONSTRUCTION DETAILS

ELMENDORF AFB
IRP STAGE 3

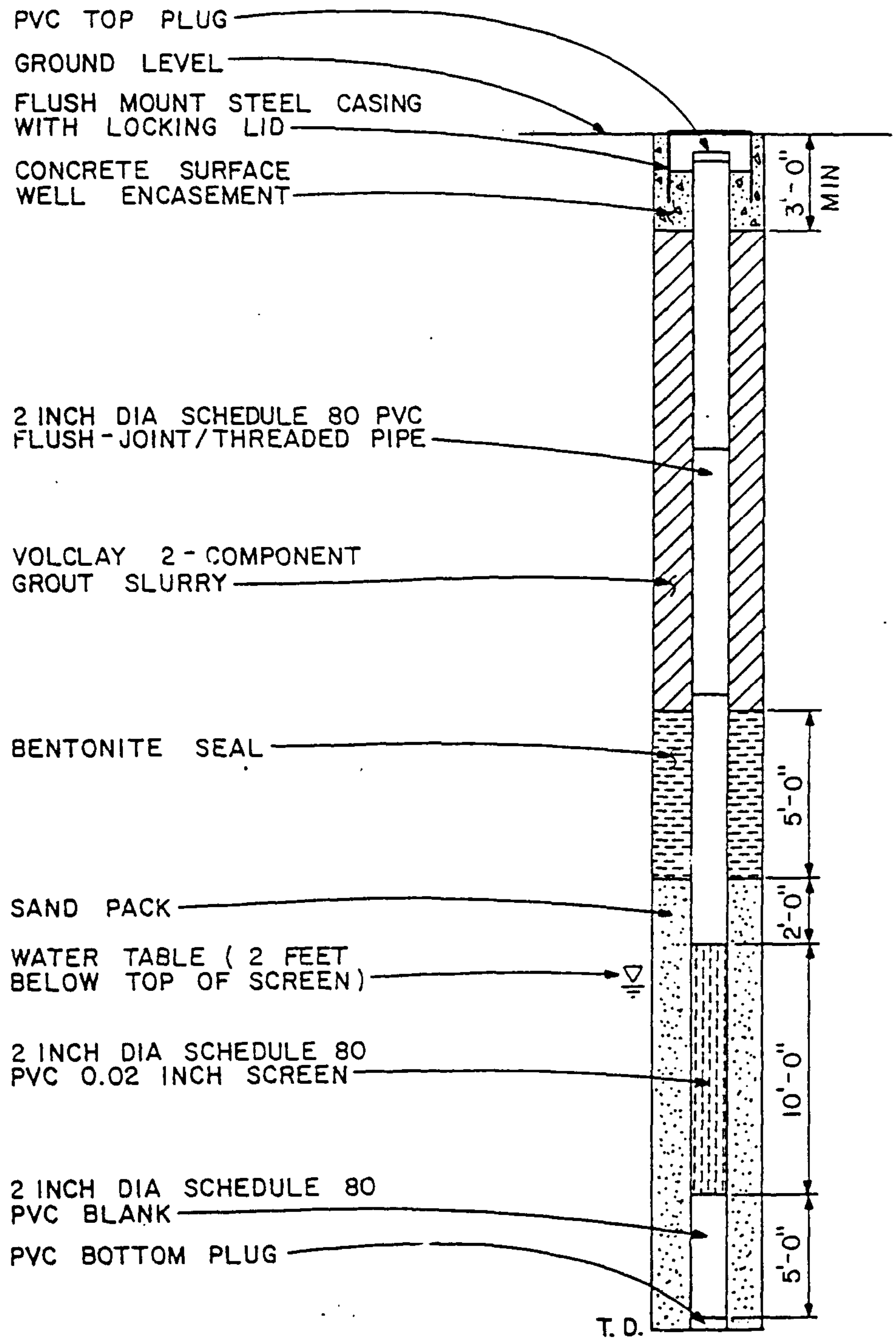


FIGURE 3-2
FLUSH MOUNTED MONITORING WELL CONSTRUCTION DETAILS

ELMENDORF AFB
IRP STAGE 3

TABLE 3-4
ELMENDORF AFB SAMPLING PROGRAM - IRP STAGE 3

SITE NUMBER	MONITORING WELL/ BORING NUMBER	NUMBER SOIL SAMPLES TAKEN	NUMBER SOIL SAMPLES TO LAB	NUMBER SEDIMENT SAMPLES TO LAB	NUMBER GROUND-WATER SAMPLES TO LAB	NUMBER SURFACE WATER SAMPLES TO LAB	NO. BARREL SAMPLES TO LAB	NO. SOIL GAS PROBES SAMPLED
D-3	D3-01	9	2	0	1	0	0	
	D3-02	6	2	0	1	0	0	
	D3-03	4	2	0	1	0	0	
	D3-04	9	2	0	0	0	0	
		28	8	0	3	0	0	37
D-5	D5-W-1	0	0	0	1	0	0	
	D5-GW-1A	0	0	0	1	0	0	
	D5-GW-1C	0	0	0	1	0	0	
	D5-GW-2A	0	0	0	1	0	0	
		0	0	0	4	0	0	0
D-7	D7-W-5	0	0	0	1	0	0	
	D7-W-6	0	0	0	1	0	0	
	D7-GW-1B	0	0	0	1	0	0	
	D7-GW-2B	0	0	0	1	0	0	
	D7-GW-2C	0	0	0	1	0	0	
		0	0	0	5	0	0	0
D-13	D13-01	9	2	0	1	0	0	
	D13-02	7	2	0	1	0	0	
	D13-03	8	2	0	1	0	0	
	D13-04	9	2	0	0	0	0	
		33	8	0	3	0	0	0
D-15	D15-01	2	2	0	0	0	0	
	D15-02	2	2	0	0	0	0	
		4	4	0	0	0	0	0
D-16	D16-01	2	2	0	0	0	0	
	D16-02	2	2	0	0	0	0	
	D16-03	2	2	0	0	0	0	
	D16-04	2	2	0	0	0	0	
		8	8	0	0	0	0	0

TABLE 3-4
ELMENDORF AFB SAMPLING PROGRAM - IRP STAGE 3

SITE NUMBER	MONITORING WELL/ BORING NUMBER	NUMBER SOIL SAMPLES TAKEN	NUMBER SOIL SAMPLES TO LAB	NUMBER SEDIMENT SAMPLES TO LAB	NUMBER GROUND-WATER SAMPLES TO LAB	NUMBER SURFACE WATER SAMPLES TO LAB	NO. BARREL SAMPLES TO LAB	NO. SOIL GAS PROBES SAMPLED
D-17	D17-01	2	2	0	0	0	0	
	D17-02	2	2	0	0	0	0	
	D17-03	2	2	0	0	0	0	
	D17-04	2	2	0	0	0	0	
	D17-05	2	2	0	0	0	0	
	D17-06	2	2	0	0	0	0	
	D17-W-11	0	0	0	1	0	0	
	D17-W-13	0	0	0	1	0	0	
		12	12	0	2	0	0	54
IS	IS-1	7	2	0	1	0	0	
	IS-2	8	2	0	1	0	0	
	IS-3	9	2	0	1	0	0	
	IS-4	6	2	0	1	0	0	
	IS-5	9	2	0	1	0	0	
	IS-6	10	2	0	1	0	0	
	IS-7	4	2	0	1	0	0	
	IS-8	5	2	0	1	0	0	
	IS-W-18	0	0	0	1	0	0	
	IS-W-19	0	0	0	1	0	0	
		58	16	0	10	0	0	0
S-6	S6-01	1	1	0	0	0	0	
	S6-02	1	1	0	0	0	0	
	S6-03	1	1	0	0	0	0	
	S6-04	1	1	0	0	0	0	
	S6-05	1	1	0	0	0	0	
	S6-06	1	1	0	0	0	0	
		6	6	0	0	0	0	0
SP-1	SP1-01	4	2	0	1	0	0	
	SP1-02	11	2	0	1	0	0	
		15	4	0	2	0	0	10

TABLE 3-4
ELMENDORF AFB SAMPLING PROGRAM - IRP STAGE 3

SITE NUMBER	MONITORING WELL/ BORING NUMBER	NUMBER SOIL SAMPLES TAKEN	NUMBER SOIL SAMPLES TO LAB	NUMBER SEDIMENT SAMPLES TO LAB	NUMBER GROUND-WATER SAMPLES TO LAB	NUMBER SURFACE WATER SAMPLES TO LAB	NO. BARREL SAMPLES TO LAB	NO. SOIL GAS PROBES SAMPLED
SP-2/6	SP2/6-01	8	1	0	1	0	0	
	SP2/6-02	8	1	0	1	0	0	
	SP2/6-03	9	1	0	1	0	0	
	SP2/6-04	8	1	0	1	0	0	
	SP2/6-05	7	1	0	1	0	0	
	SP2/6-06	9	1	0	0	0	0	
	SP2/6-07	9	1	0	0	0	0	
	SP2/6-08	8	1	0	0	0	0	
	SP2/6-09	7	1	0	0	0	0	
	SP2/6-10	8	1	0	0	0	0	
	SP2/6-W-16	0	0	0	1	0	0	
	SP2/6-GW-6A	0	0	0	1	0	0	
		81	10	0	7	0	0	28
SP-4	SP4-01	5	2	0	1	0	0	
	SP4-02	5	2	0	1	0	0	
	SP4-03	8	2	0	1	0	0	
		18	6	0	3	0	0	18
SP-5	SP5-01	9	2	0	1	0	0	
	SP5-02	7	3	0	1	0	0	
	SP5-03	8	2	0	0	0	0	
	SP5-04	10	2	0	0	0	0	
	SP5-05	8	2	0	0	0	0	
	SP5-06	7	3	0	1	0	0	
	SP5-07	9	2	0	1	0	0	
	SP5-08	5	2	0	1	0	0	
	SP5-09	8	2	0	0	0	0	
	SP5-10	5	2	0	1	0	0	
	SP5-11	2	2	0	0	0	0	
	SP5-12	2	2	0	0	0	0	
	SP5-13	2	2	0	0	0	0	
	SP5-20	2	2	0	1	0	0	
SP-5A	SP5A-14	3	2	0	0	0	0	
	SP5A-15	4	4	0	1	0	0	
	SP5A-16	3	3	0	1	0	0	
	SP5A-17	5	3	0	0	0	0	
	SP5A-18	3	3	0	1	0	0	
	SP5A-19	3	3	0	1	0	0	
		105	48	0	11	0	0	98

TABLE 3-4
ELMENDORF AFB SAMPLING PROGRAM - IRP STAGE 3

SITE NUMBER	MONITORING WELL/ BORING NUMBER	NUMBER SOIL SAMPLES TAKEN	NUMBER SOIL SAMPLES TO LAB	NUMBER SEDIMENT SAMPLES TO LAB	NUMBER GROUND-WATER SAMPLES TO LAB	NUMBER SURFACE WATER SAMPLES TO LAB	NO. BARREL SAMPLES TO LAB	NO. SOIL GAS PROBES SAMPLED
SP-7/10	SP7/10-01	6	2	0	1	0	0	
	SP7/10-02	5	2	0	1	0	0	
	SP7/10-03	6	2	0	1	0	0	
	SP7/10-04	5	2	0	1	0	0	
	SP7/10-W-3	0	0	0	1	0	0	
	SP7/10-W-4	0	0	0	1	0	0	
		22	8	0	6	0	0	60
SP-11	SP11-W-14	0	0	0	1	0	0	
	SP11-GW-4A	0	0	0	1	0	0	
		0	0	0	2	0	0	15
SP-12	SP12-W-9	0	0	0	1	0	0	
	SP12-GW-3A	0	0	0	1	0	0	
		0	0	0	2	0	0	0
SP-13	SP13-01	1	1	0	0	0	0	
	SP13-02	1	1	0	0	0	0	
		2	2	0	0	0	0	0
SP-14	SP14-01	8	2	0	1	0	0	
	SP14-02	9	2	0	1	0	0	
	SP14-W-17	0	0	0	[illegible]	0	0	
	SP14-GW-7A	0	0	0	[illegible]	0	0	
		17	4	0	4	0	0	19
SP-15	SP15-01	6	2	0	1	0	0	
	SP15-02	6	2	0	1	0	0	
		12	4	0	2	0	0	18
NS-1	NS1-01	0	0	1	0	1	0	
	NS1-02	0	0	1	0	1	0	
	NS1-03	0	0	1	0	1	0	
	NS1-04	0	0	1	0	1	0	
		0	0	4	0	4	0	0

TABLE 3-4
ELMENDORF AFB SAMPLING PROGRAM - IRP STAGE 3

SITE NUMBER	MONITORING WELL/ BORING NUMBER	NUMBER SOIL SAMPLES TAKEN	NUMBER SOIL SAMPLES TO LAB	NUMBER SEDIMENT SAMPLES TO LAB	NUMBER GROUND-WATER SAMPLES TO LAB	NUMBER SURFACE WATER SAMPLES TO LAB	NO. BARREL SAMPLES TO LAB	NO. SOIL GAS PROBES SAMPLED
NS-2	NS2-01	8	2	0	1	0	0	
	NS2-02	8	2	0	1	0	0	
		16	4	0	2	0	0	0
NS-3	NS3-01	5	2	0	0	0	0	
	NS3-02	5	2	0	1	0	0	
	NS3-03	3	2	0	1	0	0	
	NS3-04	5	2	0	0	0	0	
	NS3-05	5	2	0	0	0	0	
	NS3-06	7	2	0	1	0	0	
		30	12	0	3	0	0	26
SHIP CREEK (SC)	SC-4	0	0	1	0	1	0	
	SC-5	0	0	1	0	1	0	
	SC-6	0	0	1	0	1	0	
		0	0	3	0	3	0	0
BASE WELLS (BW)	BW-1	0	0	0	1	0	0	
	BW-2	0	0	0	1	0	0	
	BW-52	0	0	0	1	0	0	
		0	0	0	3	0	0	0
BASE HYDRO (BH)	BH-01	9	2	0	1	0	0	
	BH-02	10	2	0	0	0	0	
	BH-03	5	1	0	1	0	0	
	BH-04	4	2	0	1	0	0	
	BH-05	3	2	0	1	0	0	
	BH-06	2	2	0	1	0	0	
		33	11	0	5	0	0	0

TABLE 3-4
ELMENDORF AFB SAMPLING PROGRAM - IRP STAGE 3

SITE NUMBER	MONITORING WELL/ BORING NUMBER	NUMBER SOIL SAMPLES TAKEN	NUMBER SOIL SAMPLES TO LAB	NUMBER SEDIMENT SAMPLES TO LAB	NUMBER GROUND-WATER SAMPLES TO LAB	NUMBER SURFACE WATER SAMPLES TO LAB	NO. BARREL SAMPLES TO LAB	NO. SOIL GAS PROBES SAMPLED
PUMP TEST	PT-01	7	0	0	0	0	0	
	PT-02	5	0	0	0	0	0	
	PT-03	7	0	0	0	0	0	
	PT-04	8	0	0	0	0	0	
		27	0	0	0	0	0	0
BARREL SAMPLES (COMPO-SITES)	123	0	0	0	0	0	1	
	456	0	0	0	0	0	1	
	7	0	0	0	0	0	1	
	8910	0	0	0	0	0	1	
		0	0	0	0	0	4	0
BASE-WIDE TOTALS		527	175	7	79	7	4	383

Soil gas surveys were performed at 11 sites, with a total of 383 soil gas sampling locations. A total of 527 soil samples were taken from boreholes at 19 sites and 175 of these soil samples were sent to the laboratory for analysis. In addition, 79 groundwater samples were taken from monitoring wells established in boreholes at 19 sites. Seven surface sediment and 7 surface water samples were also collected.

The contaminated soil cuttings identified during drilling were collected and containerized during the drilling operation. There were a total of 7 barrels (numbered 1 through 7) containing contaminated soil cuttings. One laboratory sample was composited from every 3 barrels (sample numbers 123, 456, and 7). Decontamination residue remaining after evaporation of the water in the decontamination pad was also containerized into 3 barrels. The contents of these 3 barrels were composited for 1 laboratory sample (sample number 8910) and analyzed to assist in their disposition.

3.6.2 Sampling Methodology and Protocols

Discussion of the sample methodology and protocols is divided into three categories, soil gas, water, and soil/sediment sampling. Soil gas methodology incorporated gas sampling of the vadose zone and was previously discussed in Section 3.4.2. Water sampling included both groundwater and surface water collection, while soil/sediment sampling included collection protocols for soils, sediment, and containerized material (barrels).

3.6.2.1 Water Sampling

A total of 79 groundwater samples were collected from 53 monitoring wells installed during this program and from 26 existing wells. These

groundwater samples were obtained to observe groundwater quality. Seven surface water samples were also collected.

The sample equipment used in sampling groundwater and surface water included:

- 1-Liter glass beaker.
- YSI Model 33 salinity, conductivity, and temperature probes.
- Beckman Ø 21 pH meter.
- Geo-filter apparatus including tygon tubing and 0.45 umm cellulose acetate or cellulose nitrate filters.
- Pre-cleaned, capped and labeled sample containers.
- Teflon bailer with Teflon-coated 100-pound test fishing line.
- Water level indicator.

All equipment was assembled, calibrated, and tested prior to arriving at the sample or well location. In addition, all items which may have come in contact with the water were decontaminated. Sample equipment decontamination was performed at the beginning of each field day, immediately prior to each well, and at the end of each field day. The decontamination procedure included the following steps:

1. Cleaning of equipment in laboratory grade detergent solution, by use of brushes and disposable handiwipes as necessary.

2. A rinse in potable water, followed by spray rinses using ASTM Type II reagent water, then pesticide-grade methanol, and a final spray rinse with pesticide-grade hexane.

3. Air drying of equipment.

Appropriate safety equipment was worn during both groundwater and surface water sampling procedures, and in all cases chemically inert disposable gloves were worn.

The procedure for sampling the surface water consisted of submerging the 1-Liter glass beaker directly into the surface water. The sample bottles were filled directly from the beaker. The sample bottles were pre-preserved as described in Section 3.6.3. If filtering was required, water in the collection beaker was pumped through the filter into the prepared sample bottle. After the sample bottles were filled, the beaker was again filled with surface water and field measurements including conductivity, pH and temperature readings were taken. The sample containers were labeled with date, time and sampler's initials, and the samples were sealed for shipment to the laboratory in coolers with blue ice.

Sampling procedures for the groundwater were similar except that a bailer rather than a beaker was used to obtain the groundwater. In addition, several precautionary measures were taken to ensure that the well was in good condition and that the water was allowed to recharge between removing each bailer full of groundwater if the well recharged slowly. Before a monitoring well was sampled the well was checked for visible above ground damage. After the well cap was removed, the depth to water and total well depth was measured and the volume of water in the well was calculated. If, after purging, the water level had dropped greater than 1 foot, the well was allowed to recharge before samples were taken. In several cases at Elmendorf AFB, the wells were bailed dry before 3 volumes had been removed and recharge of groundwater was very slow. In these instances, it was necessary to wait several hours (not exceeding 24 hrs) before sufficient volume was available for sampling.

3.6.2.2 Soil/Sediment Sampling

A total of 527 soil samples were taken during the Stage 3 drilling operation. Of those, 175 soil samples were sent to the laboratory for analysis. In addition to the subsurface soil samples, 7 sediment samples were collected for analysis, and samples from 10 barrels of containerized material were composited for analysis.

The equipment used during the collection of soil samples, sediment samples and barrel contents at Elmendorf AFB included:

Metal trowel, spoon or scoop.
Precleaned, capped sample containers.
2-1/2 inch ID steel split spoon.
HNu photoionizing detector.

All equipment was assembled prior to arriving at the site. All items which had the potential to contact the samples were decontaminated. Between sampling locations all items which came in contact with the samples were either disposed of or thoroughly decontaminated. Appropriate safety equipment was worn during the sampling operation and in all cases chemically inert disposable gloves were worn.

A decontaminated split spoon sampler was used for collecting subsurface soil samples. The sampler was driven approximately 18 inches into undisturbed soil at the base of the boring by use of a 300-pound hammer. The sampler was then lifted out and the contents were scanned with an HNu probe for organic vapors. Soil was scooped into the sample containers using a decontaminated trowel. The soil was also visually classified according to the Unified Soil Classification System and the findings recorded on the boring log. The sample containers were labeled with date, time and sampler's

initials, and then the samples were sealed for shipment to the lab. Subsurface soil samples were collected, scanned for volatile organics and classified at 5-foot intervals in each boring and well drilled at Elmendorf AFB. However, only a predetermined number of samples at various locations and depths (including those that exhibited a potential to be contaminated via visual observation, odor, or HNu readings) were submitted for laboratory analysis.

The sampling procedure for collecting sediment samples consisted of scooping sediment from beneath the water at the stream edge. The person taking the sample would then fill the sample containers taking care not to touch the trowel to the bottle. If it was necessary to cross or wade into the water to obtain a sediment sample, the person taking the sample entered the water downstream of the sample point, and care was taken to disturb the sediment as little as possible.

The sampling procedure for collecting material from the barrelled soil cuttings and decontamination residue consisted of compositing the contents from 3 barrels into 1 laboratory sample. First the ring and lid were removed from a barrel. Then, using a decontaminated trowel, a small amount of soil or decontamination residue was placed into the sample container. Efforts were made to obtain a representative sample by sampling from various locations in each barrel. After sampling, the ring and lid were replaced, and the trowel was decontaminated. This process was repeated for each of the remaining 2 barrels to obtain the appropriate composited sample. The composited material from the 3 barrels was collected in the single sample container and shipped to the laboratory to determine the disposal status of the drill cuttings.

Equipment decontamination procedures for both sediment and subsurface soil collection were identical to those described in Section 3.6.2.2.

All trowels and split spoon samplers were decontaminated onsite at the borehole for use at each new sampling depth.

3.6.3 Sample Preservation Methods, Required Containers and Holding Times

Sample containers with the proper chemical preservative for each of the chemical analyses requested were supplied to the field crew by the analytical laboratory. Each container was labeled with the appropriate analysis prior to arrival at the sample site. After collection, all of the samples were chilled to 4 C using blue ice and/or a refrigerator and shipped to the laboratory in coolers with blue ice. Environmental Protection Agency established guidelines were used to determine allowable holding times. Table 3-5 lists the analysis performed, the container and preservative used, and the holding time. In some cases, the test method number requested differed from the test method number used by the laboratory, as explained in Section 3.7.2.

3.6.4 Field Quality Assurance/Quality Control (QA/QC) Program

Quality assurance protocol was strictly enforced throughout the entire sampling program. Table 3-6 shows a comparison between QA/QC samples requested and those taken.

In addition to the primary calibration standards, periodic check analyses of standards were performed during the soil gas surveys. Quality control samples included duplicate and replicate sample analyses, GC system blanks, background air sample analysis, probe blanks, and calibration standards. Total quality control analysis was greater than 20 percent of the basic sample load.

TABLE 3-5. SAMPLE PRESERVATION, CONTAINER REQUIREMENTS AND HOLDING TIMES

PARAMETER	MEDIA	METHOD NO.	SAMPLE VOLUME	CONTAINER	PRESERVATIVE METHOD	HOLDING TIME
Lead	Water	239.2	600 ml	1 L polyethylene bottle	HNO_3 to pH < 2 Chill to 4 C	< 6 months
	Soil	6010	200 grams	16 oz. wide-mouth glass or polyethylene bottle	Chill to 4 C	< 6 months
Mercury	Water	245.1	600 ml	1 L polyethylene bottle	HNO_3 to pH < 2 Chill to 4 C	< 28 days
	Soil	7471	200 grams	16 oz. wide-mouth glass	Chill to 4 C	< 28 days
Selenium	Water	270.2	600 ml	1 L polyethylene bottle	HNO_3 to pH < 2 Chill to 4 C	< 6 months
Volatile Organics	Water	601, 602	80 ml	2-40 mL glass vials with Teflon-lined septum caps	4 drops 1:1 HCl Chill to 4 C	< 14 days
	Soil	8240	8 oz.	8 oz. wide-mouth glass with Teflon liner	Chill to 4 C	< 14 days
Organochlorine Pesticides and PCBs	Water	608	1 Liter	1 L glass bottle	Chill to 4 C	7 days (extraction) 40 days (analysis)
	Soil	8080	8 oz.	16 oz. wide-mouth glass	Chill to 4 C	14 days (extraction)
Total Dissolved Solids	Water	160.1	1 Liter	1 L polyethylene or glass bottle	Chill to 4 C	< 7 days
Total Solids	Soil	160.3	10 grams	16 oz. wide-mouth glass	Chill to 4 C	< 28 days
Common Anions	Water	300	1 Liter	1 L polyethylene bottle	Chill to 4 C	Nitrate: 48 hours < 28 days for other

TABLE 3-5. SAMPLE PRESERVATION, CONTAINER REQUIREMENTS AND HOLDING TIMES

PARAMETER	MEDIA	METHOD NO.	SAMPLE VOLUME	CONTAINER	PRESERVATIVE METHOD	HOLDING TIME
Petroleum Hydrocarbons (TPH)	Water	418.1	1 Liter	1 L glass bottle	5 ml HCl Chill to 4 C	< 28 days
	Soil	3550	8 oz.	16 oz. wide-mouth glass	Chill to 4 C	< 28 days (extraction) < 40 days (analysis)
1,2-Dibromoethane	Water	504	80 ml	2-40 ml glass vials with Teflon-lined septum caps	Chill to 4 C	< 28 days
Metals (ICP)	Water	200.7	1 Liter	1 L polyethylene bottle	HNO_3 to pH < 2 Chill to 4 C	< 6 months
	Soil	6010	6 oz.	16 oz. wide-mouth glass	Chill to 4 C	< 6 months
Arsenic	Water	206.2	600 ml	1 L polyethylene bottle	HNO_3 to pH < 2 Chill to 4 C	< 6 months
Extractable Priority Pollutants/Semi-Volatiles	Water	625	1 Liter	1 L glass bottle	Chill to 4 C	7 days (extraction) 40 days (analysis)
	Soil	8270	8 oz.	16 oz. wide-mouth glass with Teflon liner	Chill to 4 C	14 days (extraction) 40 days (analysis)
Cyanide	Water	335.3	500 ml	500 ml polyethylene or glass	2 ml 10 n NaOH Chill to 4 C	< 14 days
	Soil	9010	8 oz.	16 oz. wide-mouth glass	Chill to 4 C	< 14 days

TABLE 3-6
QUALITY ASSURANCE/QUALITY CONTROL SAMPLING PROGRAM - IRP STAGE 3

SAMPLE TYPE	ANALYSIS	NO. SAMPLES REQUESTED	NO. SAMPLES TAKEN	DIFFERENCE
SOILS/SEDIMENTS				
Trip Blank	8240	18	29	11
Duplicate/ Replicate	3550	18	18	0
	6010	10	10	0
	1310	1	1	0
	7471	7	7	0
	8080	4	4	0
	8240	18	18	0
	8270	11	11	0
	9010	2	2	0
Matrix Spike/ Matrix Spike Duplicate	8080	2	1	-1
	8240	10	7	-3
	8270	6	3	-3
WATERS				
Trip Blanks	601	5	5	0
	8015	2	2	0
	602	9	13	4
Field Blanks	504	0	2	2
	601	5	12	7
	602 modified	2	4	2
	602	9	22	13
Equipment Blank	160.1	12	18	6
	300	6	9	3
	418.1	15	18	3
	504	2	2	0
	200.7	6	10	4
	206.2	6	10	4
	239.2	8	11	3
	245.1	6	10	4
	270.2	6	10	4
	601	7	10	3
	602 modified	3	4	1
	602	15	18	3
	608	2	3	1
	625	9	12	3
	335.3	3	3	0

TABLE 3-6
QUALITY ASSURANCE/QUALITY CONTROL SAMPLING PROGRAM - IRP STAGE 3

SAMPLE TYPE	ANALYSIS	NO. SAMPLES REQUESTED	NO. SAMPLES TAKEN	DIFFERENCE
Duplicate/ Replicate	160.1	9	9	0
	300	4	4	0
	418.1	9	9	0
	504	2	2	0
	200.7	4	4	0
	206.2	4	4	0
	239	5	5	0
	245.1	4	4	0
	270.2	4	4	0
	601	5	5	0
	602 modified	2	2	0
	602	9	9	0
	608	2	2	0
	625	6	6	0
	335.3	2	2	0
Matrix Spike/ Matrix Spike Duplicate	504	1	1	0
	601	3	3	0
	602 modified	1	1	0
	602	5	5	0
	608	1	1	0
	625	3	3	0

3.6.4.1 Field QA/QC for Soil/Sediment and Water Sampling

QA/QC samples were periodically prepared and submitted for analysis with the primary samples. All QA/QC samples were handled and transported in the same manner as the primary water or sediment/soil samples. The QA/QC samples consisted of field (ambient conditions), trip and equipment blanks, duplicate water samples and replicate sediment/soil samples described as follows:

- <u>Field Blank</u>: One field ambient conditions blank sample was prepared in the field for each shipment VOC samples (water) to the laboratory. Laboratory-grade organic-free (ASTM Type II Reagent) water was used. Each field blank was analyzed for volatile organics.

- <u>Trip Blanks</u>: Trip blanks were prepared by the laboratory before going into the field and accompanied the sample containers throughout the sampling operation. One trip blank was submitted with each shipment for analysis of VOC samples (both soil and water). The sample was prepared by filling sample container with ASTM Type II Reagent water, transporting it to the sampling site, storing on site, and then sending it to the laboratory for testing of volatile organics. The trip blank was not opened in the field.

- <u>Equipment Blank</u>: One equipment blank was prepared each day for each of the parameters to be analyzed that day. The equipment blanks were prepared by filling a precleaned sampling device with laboratory-grade organic-free water and then transferring the water from the sampler to the sample bottles.

- <u>Replicate</u>: One replicate sample for approximately every 10 soil samples was collected and submitted for analysis. Each

replicate was analyzed for the same parameters as the primary sample at that location.

- Duplicate: One duplicate sample for approximately every 10 water samples was collected and submitted for analysis. Each duplicate was analyzed for the same parameters as the primary sample at that location.

3.7 LABORATORY PROGRAM

3.7.1 Identification of Laboratory

Enseco Rocky Mountain Analytical Laboratory of Arvada, Colorado performed all laboratory analysis.

3.7.2 Description of Analytical Parameters

The test methods identified in the Elmendorf AFB IRP Stage 3 Work Plan identified the analytical parameter and corresponding test method. These test methods were for solid waste samples only. When an aqueous sample was shipped for analysis the solid waste test method was identified on the chain of custody form. Aqueous samples cannot be analyzed using solid waste test methods. The analyzing laboratory (ENSECO) was familiar with this type of sample labeling and corrected the test method upon receipt of the samples. Table 3-7 clarifies which test method was used to analyze the parameters. The analytical methodology/laboratory equipment used to perform analyses on samples taken during the field effort are presented in Table 3-8. The table also indicates the parameters being analyzed. Analytical interferences including spectral, physical, and chemical interferences may affect analytical procedures and method reliability. A discussion of these interferences and their effect on method reliability are

TABLE 3-7

ANALYTICAL METHODS

Parmeter	Work Plan Test Method	Soil Test Method	Aqueous Test Method
Total Dissolved Solids	E160.1	NA	160.1
Total Solids	E160.3	160.3	NA
Lead (Total)	SW7420	6010	2392
Lead (Recoverable)	SW7421	6010	2392
Lead (Dissolved)	SW7421	6010	2392
Total Petroleum Hydrocarbons	SW3550/E418.1	3550	418.1
Volatile Organic Compounds	SW8240	8240	624
Organochloride Pesticides and PCB's	SW8080	8080	608
Halogenated Volatile Organics	SW8010	8010	601
Non-halogenated Volatile Organic Compounds	SW8015		602 modified
Aromatic Volatile Organics	SW8020	8020	602
Semi-Volatile Organics	SW8270	8270	625
Mercury	SW7470	7471	245.1
Selenium	SW7740	NA	270.2
Arsenic	SW7060	6010	206.2
Cyanide	SW9010	9010	335.3
Common Anions	E300	NA	300.0
1,2-Dibromoethane	E504	NA	5021
Metals	SW6010	6010	200.7
Extraction Procedures Toxicity, Metals Only	SW1310	1310	NA

TABLE 3-8. ANALYTICAL METHODOLOGY/LABORATORY INSTRUMENTATION

Parameter	Medium	Test Method No.	Methodology/Instrumentation[1]
Volatile Organics	Water	601	Purge and Trap, GC/Hall
Volatile Organics	Water	602 modified	Purge and Trap, GC/FID
Volatile Organics	Water	602	Purge and Trap, GC/PID
Volatile Organics	Soil	8240	Purge and Trap, GC/MS
Extractable Priority Pollutants/Semi-Volatiles	Water	625	Extraction, GC/MS
Extractable Priority Pollutants/Semi-Volatiles	Soil	8270	Extraction, GC/MS
Organochlorine Pesticides and PCB's	Water	608	Extraction, GC/ECD
Organochlorine Pesticides and PCB's	Soil	8240	Extraction, GC/ECD
Total Dissolved Solids	Water	160.1	Gravimetric, 180°C
Total Solids	Soil	160.3	Gravimetric, 105°C
Common Anions	Water	300	Ion Chromatography
Petroleum Hydrocarbons	Water	418.1	Freon Extraction, Infrared GC/MS
Petroleum Hydrocarbons	Soil	3550	Freon Extraction, Infrared GC/MS
Metals (ICP)	Water	200.7	ICP Emission Spectroscopy
Metals (ICP)	Soil	6010	ICP Emission Spectroscopy

TABLE 3-8 (continued). ANALYTICAL METHODOLOGY/LABORATORY INSTRUMENTATION

Parameter	Medium	EPA Method No.	Methodology/Instrumentation[(1)]
Arsenic	Water	206.2	Furnace Atomic Absorption
Lead	Water	239.1/239.2	Furnace Atomic Absorption
Lead	Soil	7421	Furnace Atomic Absorption
Mercury	Water	245.1	Cold Vapor Atomic
Mercury	Soil	7471	Cold Vapor Atomic
Selenium	Water	270.2	Furnace Atomic Absorption
Cyanide	Water	335.3	Distillation Colorimetric
Cyanide	Soil	9010	Distillation Colorimetric

(1) GC - Gas Chromatograph
MS - Mass Spectrometer
Hall - Electrolytic Conductivity
FID - Flame Ionization
PID - Photoionization
ECD - Electron Capture
ICP - Ionic Coupled Plasma

included in EPA document SW846 - "Test Methods for Evaluating Solid Waste".

The analyses detected a number of volatile organic and semi-volatile compounds, pesticides and PCBs, common anions, and metals. The analyses also detected petroleum hydrocarbons and quantified total solids in soil samples and total dissolved solids in water samples.

3.7.3 Laboratory QA/QC Program

The laboratory QA/QC program plan is included in Appendix B of the QAPP for the IRP Stage 3, RI/FS, dated June 1988. Appendix B of the QAPP presents the policies, organization, objectives, functional activities, and QA activities associated with the analytical work performed for the IRP Stage 3.

The procedures used to establish detection limits are presented in Section 12 of Appendix B of the QAPP. Table 3-9 presents the type and frequency of laboratory QA/QC data. Laboratory QA/QC data such as blanks, spikes, and duplicates as well as analytical data from water, soil, sediment, and air sampling are included in Appendix G of this report.

Laboratory Performance QC is based on the use of standard control matrices to generate precision and accuracy data which are compared, on a daily basis, to control limits. Initially, control limits are taken directly from the Contract Laboratory Program (CLP). If CLP limits are not available, Enseco historical data are used to set the control limits. As sufficient laboratory data become available, the control limits are redefined based upon the most recent 6 months of Laboratory Control Sample (LCS) data. Control limits for accuracy are based on the historical average recovery of the LCS plus or minus 3 standard deviation units. Control limits for precision are

TABLE 3-9. FREQUENCY AND TYPE OF LABORATORY QUALITY CONTROL SAMPLES

Analytes	Methods	Blanks		Duplicates		Matrix Spike Sample	Lab Control Sample	Surro-gates	PE Samples
		Method Blank	Field Blank	Duplicate Sample	Spike Duplicate				
CERCLA - Superfund (CLP)									
Water, soil, waste samples									
QC - Pest. & PCB's	608-CLP	5%, ESS	Req	-	5%, ESS	5%, ESS	-	Req.	Qtrly.
GC/MS Purgeables (VOA)	624-CLP	Daily,ESS	Req	-	5%, ESS	5%, ESS	-	ACC	Qtrly.
GC/MS Semivolatiles	625-CLP	5%, ESS	Req	-	5%, ESS	5%, ESS	-	ACC	Qtrly.
Metals - AA	200.0-CLP	5%, ESS	Req	5%	-	5%, ESS	ESS	-	Qtrly.
ICP	200.7-CLP	5%, ESS	Recom.	5%	-	5%, ESS	ESS	-	Qtrly.

ESS - Each sample set

Req - Surrogates required, no acceptance criteria

CLP - Contract Laboratory Program

Qtrly - Quarterly

Recom - Recommended

based on the historical Relative Percent Difference (RPD) and range from zero (no difference between duplicate LCS results) to the average RPD plus 3 standard deviation units. Calculated control limits tend to be tighter than CLP limits because of the use of a control matrix. However, if the calculated limits are broader than the CLP limits, the CLP limits are used to control the laboratory. The QC data for this study is provided in Appendix R.

IV. RESULTS AND SIGNIFICANCE OF FINDINGS

4.1 INTRODUCTION

The results and significance of findings of the field investigation program are included in this section. Before presenting the results of the field investigation program, information is needed on groundwater and soil cleanup levels, background metals values, carcinogenic risks of contaminants detected at Elmendorf AFB, and criteria for prioritization of sites for further IRP effort. This information is necessary to better characterize the sites and determine the degree of contamination at each site. A discussion of these 4 items is presented below.

4.1.1 Groundwater and Soil Cleanup Levels

For groundwater that is a current or potential source of drinking water, cleanup levels are either based on a baseline risk assessment or chemical-specific applicable or relevant and appropriate requirements (ARARS). The State of Alaska Water Quality Standards (18 AAC 70.050) classify all state groundwater as drinking water supply. The term groundwater applies to perched water lenses and unconfined and confined aquifers.

The following system for determining groundwater cleanup levels is applicable to Elmendorf AFB. If a Safe Drinking Water Act (SDWA) Maximum Contaminant Level (MCL) or proposed MCL exists, it is used unless there is a more stringent state standard. MCLs are enforceable standards for public water systems. They are set as close to the Maximum Contaminant Level Goals (MCLGs) as feasible. Feasible means with the use of the best technology, treatment techniques and other means, taking cost into consideration. MCLGs are nonenforceable health goals for drinking water set at a level representing "no known or anticipated adverse effects on the health of persons" while allowing for an adequate margin of safety. MCLGs were formerly termed Recommended Maximum Contaminant Levels (RMCLs).

Secondary MCLs apply to contaminants, which when present in excessive quantities, may discourage the utilization of a public water supply. Secondary MCLs are considered nonenforceable and deal with such qualities as taste, color, odor, and corrosivity. If there are no MCLs or proposed MCLs, but there is a state standard, the state standard is used. If none of the preceding exists, National Ambient Water Quality Criteria (NAWQC), developed under the Clean Water Act, are used. The NAWQC used at hazardous waste sites are generally based on the protection of human health, from the consumption of drinking water, with a cancer risk level of 10^{-6}. The cleanup value selection process is summarized below:

1. Use the MCL or proposed MCL unless a more stringent state standard exists.
2. Use state standards.
3. Use NAWQC for consumption of drinking water and a 10^{-6} cancer risk.

State of Alaska Water Quality Standards (18 AAC 70.010) indicate that petroleum hydrocarbons, oil and grease "shall not cause a visible sheen upon the surface of the water. Shall not exceed concentrations which individually or in combination impart odor or taste as determined by organoleptic tests." Therefore, field observations of a sheen or odor were used to determine if State of Alaska Water Standards were exceeded for petroleum hydrocarbons.

Groundwater cleanup levels for organic and inorganic contaminants detected at Elmendorf AFB are presented in Table 4.1.1 and 4.1.2 respectively.

Soil cleanup levels for carcinogens are based on a 10^{-6} cancer risk from exposure to contaminated soils and for noncarcinogens soil cleanup levels are based on reference dose levels (RDs). Normally, a 70 year exposure period is used to determine cleanup levels. Since 4 years is the average tour of duty and because children are not allowed in many of the areas where contamination was present, an exposure period less than 70 years will

TABLE 4.1.1 GROUNDWATER CLEANUP LEVELS FOR ORGANIC CONTAMINANTS - ELMENDORF AFB, AK

CONSTITUENTS	MCLs (ug/L)	PROPOSED MCLs (ug/L)	STATE OF ALASKA MCLs (ug/L)	NAWQC FOR PROTECTION OF HUMAN HEALTH FROM DRINKING WATER 10^{-6} CANCER RISK (ug/L)	GROUNDWATER CLEANUP LEVEL (ug/L)
Acenaphthene	-	-	-	-	-
Acetone	-	-	-	-	-
Aldrin	-	-	-	0.0012	0.0012
alpha-BHC	-	-	-	0.013	0.0013
delta-BHC	-	-	-	-	-
gamma-BHC (Lindane)	0.2	-	4	0.017	4
Benzene	5	-	5	0.67	5
Chlorobenzene	-	100	-	-	100
Chloroethane	-	-	-	-	-
Chloroform	100 (1)	-	100(1)	0.19	100(1)
4-Chloro-3-Methylphenol	-	-	-	-	-
2-Chlorophenol	-	-	-	-	-
1,3-Dichlorobenzene	-	-	-	-	-
1,4-Dichlorobenzene	75	-	-	-	75
1,1-Dichloroethane	-	-	-	-	-
1,2-Dichloroethane	5	-	-	0.94	5
Trans-1,2-Dichloroethene	100	-	-	-	70
Dichlorodifluoromethane	-	-	-	-	-
2,4-Dinitrotoluene	-	-	-	0.11	0.11
Ethylbenzene	700	-	700	-	700
Hexachlorocyclopentadiene	-	50	-	-	-
Hexachloroethane	-	-	-	-	-
2-Methylnaphthalene	-	-	-	-	-
4-Methyl-2-pentanone	-	-	-	-	-
Naphthalene	-	-	-	-	-
4-Nitrophenol	-	-	-	-	-
N-Nitroso-di-n-propylamine	-	-	-	-	-
N-Nitrosodiphenylamine	-	-	-	4.9	4.9
Pentachlorophenol	200	-	-	-	200
Phenol	-	-	-	-	-
Pyrene	-	-	-	-	-

TABLE 4.1.1 (Continued). GROUNDWATER CLEANUP LEVELS FOR ORGANIC CONTAMINANTS - ELMENDORF AFB, AK

CONSTITUENTS	MCLs (ug/L)	PROPOSED MCLs (ug/L)	STATE OF ALASKA MCLs (ug/L)	NAWQC FOR PROTECTION OF HUMAN HEALTH FROM DRINKING WATER 10^{-6} CANCER RISK (ug/L)	GROUNDWATER CLEANUP LEVEL (ug/L)
Tetrachloroethene	5	-	-	0.88	5
Toluene	2000	-	2000	-	2000
1,1,2,2-Tetrachloroethane	-	-	-	0.17	0.17
1,2,4-Trichlorobenzene	-	-	-	-	-
1,1,1-Trichloroethane	200	-	-	-	200
Trichloroethene	5	-	-	2.8	5
Trichlorofluoromethane	-	-	-	-	-
Vinyl Chloride	2	-	-	2	2
Xylene	10,000	-	440	-	440
Total Petroleum Hydrocarbons	-	-	Sheen or Odor	-	Sheen or Odor

(1) Trihalomethanes (100 ug/L)

TABLE 4.1.2 GROUNDWATER CLEANUP LEVELS FOR INORGANICS - ELMENDORF AFB, ALASKA

CONTAMINANT	MCL (mg/L	PROPOSED MCL (mg/L)	STATE OF ALASKA MCLs (mg/L)	NAWQC FOR PROTECTION OF HUMAN HEALTH FROM DRINKING WATER 10^{-6} CANCER RISK (mg/L)	GROUNDWATER CLEANUP LEVEL (mg/L)
Aluminum	-	-	-	-	-
Arsenic	0.03	-	0.05	0.0000025	0.05
Barium	5	-	1.0	-	1.0
Beryllium	-	.001	-	0.0000039	0.0000039
Cadmium	0.005	-	0.01	-	0.01
Calcium	-	-	-	-	-
Chloride	250(1)	-	250(1)	-	250(1)
Chromium	0.01	-	0.05	-	0.05
Cobalt	-	-	-	-	-
Copper	1.3	-	1.0(1)	-	1.0(1)
Cyanide	-	NP	-	-	-
Flouride	4	-	2.4	-	2.0(1)
Iron	0.3 (1)	-	0.3(1)	-	0.3
Lead	0.05	0.005	0.05	-	0.05
Magnesium	-	-	-	-	-
Manganese	0.05 (1)	-	0.05(1)	-	0.05(1)
Mercury	0.002	-	0.002	-	0.002
Molybdenum	-	-	-	-	-
Nickel	-	NP	-	-	-
Nitrate as N	1	-	10	-	10
Potassium	-	-	-	-	-
Selenium	-	-	0.01	-	0.01
Sodium	-	-	250(1)	-	250(1)
Silver	-	-	0.05	-	0.05
Sulfate	250(1)	250	250(1)	-	250(1)
TDS	500(1)	-	500(1)	-	500(1)
Vanadium	-	-	-	-	-
Zinc	5.0(1)	-	5.0(1)	-	5.0(1)

(1) Secondary
NP - An MCL for this contaminant will be proposed, but the proposed MCL has not been published.

be used to determine soil cleanup levels. Civilians that would be onsite for many years should not be adversely affected by this more realistic method of determining risk because the adults are probably not ingesting soil and, again, children are not allowed in many of the areas where contamination was detected. For carcinogens, an allowable daily intake value is determined by dividing risk by the contaminant's potency factor, which is based on a 70-year exposure. An example calculation for benzene is presented below:

$$\text{Allowable daily intake} = \frac{\text{risk (unitless)}}{\text{potency factor (mg/kg/day)}^{-1}}$$
$$= \frac{1 \times 10^{-6}}{0.029\ (\text{mg/kg/day})^{-1}}$$
$$= 3.45 \times 10^{-5}\ \text{mg/kg/day}$$

The allowable concentration of the contaminant in soil is determined by multiplying the allowable daily intake by the mass of the individual and dividing that quantity by the individuals daily intake of soil. Assumptions which are used to calculate the allowable contaminant concentration are presented below:

- o Adult's mass - 70 kg (EPA, 1986)
- o Child's mass - 10 kg (EPA, 1986)
- o Adult soil intake - 0.1 g/day (EPA, 1/27/89)
- o Child soil intake (age 1-6) - 0.2 g/day (EPA 1/27/89)
- o Average exposure duration = 5 years

An example calculation of the allowable concentration in soil of benzene for protection of children's health is presented below:

Allowable concentration (mg/kg)

$$= \frac{\text{Allowable daily intake (mg/kg/day)(70/5) x mass (kg)}}{\text{Daily intake (kg/day)}}$$
$$= \frac{3.45 \times 10^{-5}\ \text{mg/kg/day (70 years/5 years)} \times 10\ \text{kg}}{0.2\ \text{g/day}} \times \frac{(1000)\ \text{g}}{(\text{kg})}$$
$$= 24.15\ \text{mg/kg}$$

For noncarcinogens, a similar method is used to determine cleanup levels. Instead of using the calculated allowable daily intake value, the reference dose is used.

Calculated soil cleanup levels for organic and inorganic contaminants detected at Elmendorf AFB are presented in Table 4.1.3.

Proposed soil cleanup level guidelines for TPH in the State of Alaska are based on an assessment matrix developed by the State of California which is included in Appendix Q. Maximum allowable TPH levels are either 1000 ppm, 100ppm, or 10 ppm depending on depth to groundwater, soil characteristics, hydraulic conductivity, precipitation and migratory routes. Based on features at the sites at Elmendorf AFB it appears that the maximum allowable TPH level will be 100 ppm. However, the assessment matrix is only to be used as a tool. ADEC involvement is necessary to develop actual cleanup levels.

4.1.2 Heavy Metals

The results of the field investigation, presented in Section 4.2, revealed the presence of many heavy metals in the soils and groundwater at Elmendorf AFB. Among the most prevalent heavy metals are aluminum, iron, magnesium, and manganese. This section supplies a general discussion of the presence of heavy metals at Elmendorf AFB and provides recommendations for determining if the presence of metals at the individual sites is naturally occurring or if it is due to contamination. The presence of metals in the both the soil and the groundwater is addressed in the following sections.

TABLE 4.1.3 SOIL CLEANUP LEVELS FOR ORGANIC AND INORGANIC CONTAMINANTS - ELMENDORF AFB, ALASKA

Contaminant	EPA Weight of Evidence (1,2)	Potency Factor (mg/kg/day)	ALLOWABLE INTAKE: 70 Yr Exposure(3) (mg/kg/day)	ALLOWABLE INTAKE: 5 Yr Exposure(4) (mg/kg/day)	SOIL CLEANUP LEVELS, 5 YEAR EXPOSURE, ALLOWABLE SOIL CONCENTRATION: Adults (70 kg) (.1g/day intake) (mg/kg)	SOIL CLEANUP LEVELS, 5 YEAR EXPOSURE, ALLOWABLE SOIL CONCENTRATION: Children (10 kg) (.2g/day intake) (mg/kg)
ORGANIC COMPOUNDS						
Acctone	RFD	-	-	0.1	70,000	5,000
Aldrin	B2	17 (IRIS)	5.9×10^{-8}	8.3×10^{-7}	0.58	0.042
Gamma-BHC (Lindane)	NL	-	-	-	-	-
Benzene	A	0.029 (IRIS)	3.45×10^{-5}	4.83×10^{-4}	338	24.2
Benzo(a)anthracene	B2	-	-	-	-	-
Benzo(a)pyrene	B2	11.5	8.7×10^{-8}	1.22×10^{-6}	0.852	0.061
Benzo(b)flouranthene	B2	-	-	-	-	-
Benzo(k)flouranthene	D	-	-	-	-	-
2-Butanone (MEK)	RFD	-	-	0.05	35,000	2,500
Chlorobenzene	RFD	-	-	0.027	18,900	1,350
4,4'-DDD	B2	-	-	-	-	-
4,4'-DDT	B2	.340	2.94×10^{-6}	4.12×10^{-5}	28.8	2.06
1,1-Dichloroethene	C	0.6 (IRIS)	1.67×10^{-6}	2.33×10^{-5}	16.3	1.17
2,6-Dichlorophenol	NL	-	-	-	-	-
Dieldrin	NL	-	-	-	-	-
Endrin	NL	-	-	-	-	-
Ethanol	NL	-	-	-	-	-
Ethylbenzene	RFD	-	-	0.1	70,000	5,000
Fluoranthene	NL	-	-	-	-	-
Heptachlor	NL	-	-	-	-	-
Hexacloroethane	C	.014	7.14×10^{-5}	1.0×10^{-3}	700	50
2-Methylnapthalene	NL	-	-	-	-	-
2-Methylphenol	NL	-	-	-	-	-
4-Methylphenol	NL	-	-	-	-	-
4-Nitrophenol	NL	-	-	-	-	-
N-Nitrosodiphenyl	NL	-	-	-	-	-
Phenanthrene	NL	-	-	-	-	-
2-Picoline	NL	-	-	-	-	-
Pyrene	NL	-	-	-	-	-
Toluene	RFD	-	-	0.3	210,000	15,000
1,2,4,5-Tetrachlorobenzene	RFD	-	-	3.0×10^{-4}	210	15
Trichloroethene	B2	.011	9.09×10^{-5}	0.00127	891	63.6
Xylenes	RFD	-	-	0.01	7,000	500

TABLE 4.1.3 (Continued). SOIL CLEANUP LEVELS FOR ORGANIC AND INORGANIC CONTAMINANTS - ELMENDORF AFB, ALASKA

Contaminant	EPA Weight of Evidence (1,2)	Potency Factor (mg/kg/day)	ALLOWABLE INTAKE 70 Yr Exposure(3) (mg/kg/day)	ALLOWABLE INTAKE 5 Yr Exposure(4) (mg/kg/day)	SOIL CLEANUP LEVELS 5 YEAR EXPOSURE ALLOWABLE SOIL CONCENTRATION Adults (70 kg) (.1g/day intake) (mg/kg)	Children (10 kg) (.2g/day intake) (mg/kg)
MINERALS						
Aluminum	NL	-	-	-	-	-
Arsenic	A	1.65 (IRIS)	6.06×10^{-7}	8.49×10^{-6}	5.6	0.42
Barium	RFD	-	-	0.05 (IRIS)	35,000	2500
Beryllium	B1	-	-	-	-	-
Cadmium	NL	-	-	-	-	-
Calcium	NL	-	-	-	-	-
Chromium	RFD	-	-	1.0	700,000	50,000
Cobalt	NL	-	-	-	-	-
Copper	RFD	-	-	0.037	25,900	1,850
Iron	NL	-	-	-	-	-
Lead	RFD	-	-	1.4×10^{-3}	980	70
Magnesium	NL	-	-	-	-	-
Manganese	RFD	-	-	0.22	154,000	11,000
Mercury	RFD	-	-	2.0×10^{-3}	1,400	100
Molybdenum	NL	-	-	-	-	-
Nickel	A & RFD	-	-	0.01	7,000	500
Potassium	NL	-	-	-	-	-
Sodium	NL	-	-	-	-	-
Vanadium	RFD	-	-	0.02	14,000	1,000
Zinc	RFD	-	-	0.21	147,000	10,500

NOTES:
(1) A weight of evidence of RFD signifies a reference dose limit, not a cancer potency factor.
(2) NL signifies not listed or no RFD or potency factor in 1986 manual or IRIS database.
(3) The 70-year allowable daily intake is based on a 10E-6 cancer risk for carcinogens.
(4) The five year allowable daily intake was calculated by a simple 70 year:5 year ratio for carcinogens and the chronic allowable intake (AIC) for noncarcinogens.

Source: Superfund Public Health Evaluation Manual (EPA, 1986)

4.1.2.1 Heavy Metals in Soils

As mentioned, many metals were detected frequently throughout the site. The mean, standard deviation, and detection frequency of the metals detected in the soils at the basewide hydrogeology wells are presented in Table 4.1.4. The basewide hydrogeology wells are discussed in further detail in Section 4.2.25. Generally, these sites are not associated with any current or past base activities; therefore the metals data from these wells may be considered as indicators of naturally occurring conditions, i.e. background data.

Table 4.1.5 shows typical values for naturally occurring metals in soils. Comparison of the 2 tables show no extraordinary metals concentrations in the background soils of Elmendorf AFB.

Data from the individual sites should be compared to the 2 tables mentioned above. If the concentration of metal does not fall within the expected range for naturally occurring conditions, the metal may be attributable to contamination. Specifically, if the concentration of a metal falls outside of the 95 percent confidence interval for background concentrations based on results from the basewide hydrogeology sites (Table 4.1.4), and it falls outside the typical range for naturally occurring metals concentrations (Table 4.1.5), the metal warrants further consideration.

4.1.2.2 Heavy Metals in Groundwater

As in soils, many metals were detected in the groundwater. Again, data from the basewide hydrogeology wells will be utilized to estimate naturally occurring metals concentrations in the groundwater.

TABLE 4.1.4 HEAVY METALS IN SOILS AT BASEWIDE HYDROGEOLOGY WELLS

Metal	Mean of Detects (mg/kg)	Std. Dev. of Detects	Detection Frequency
Aluminum	11,200	2,500	6/6
Arsenic	11	0	2/6
Barium	42	11	6/6
Beryllium	0.23	0.07	6/6
Caromium	23	6.9	6/6
Cobalt	8.8	2.5	6/6
Copper	23	6.0	6/6
Iron	23,000	7,000	6/6
Lead	18	22	6/6
Magnesium	7,000	2,100	6/6
Mangenese	470	120	6/6
Mercury	0.17	0.02	3/6
Molybdenum	5.5	2.6	5/6
Nickel	24	6.7	6/6
Silver	4.4	NA	1/6
Vanadium	40	9.2	6/6
Zinc	47	15	6/6

NA - Not Applicable.

TABLE 4.1.5 TRACE CHEMICAL ELEMENT CONTENT OF NATURAL SOILS

Element	Common Range (ppm)	Average (ppm)	Element	Common Range (ppm)	Average (ppm)
Aluminum	10,000-300,000	71,000	Lithium	5-200	20
Antimony	2-10	-	Magnesium	600-6,000	5,000
Arsenic	1-50	5	Manganese	20-3,000	600
Barium	100-3,000	430	Mercury	0.01-0.3	.03
Beryllium	0.1-40	6	Molybdenum	0.2-5	2
Boron	2-100	10	Nickel	5-500	40
Bromine	1-10	5	Radium	8×10^{-5}	
Cadmium	0.01-0.7	.06	Rubidium	50-500	10
Cesium	0.3-25	6	Selenium	0.1-2	.3
Chlorine	20-900	100	Silver	0.01-5	.05
Chromium	1-1,000	100	Strontium	50-1,000	200
Cobalt	1-40	8	Tin	2-200	10
Copper	2-100	30	Tungsten		1
Fluorine	10-4,000	200	Uranium	0.9-9	1
Gallium	0.4-300	30	Vanadium	20-500	100
Gold		1	Yttrium	25-250	50
Iodine	0.1-40	5	Zinc	10-300	50
Lanthanum	1-5,000	30	Zirconium	60-2,000	300
Lead	2-200	10			

SOURCE: USEPA Office of Solid Waste and Emergency Response, HAZARDOUS WASTE LAND TREATMENT, SW-874 (April, 1983) Page 273, Table 6.46.

Both total recoverable metals and dissolved metals data were collected. Table 4.1.6 shows the mean, standard deviation, and detection frequency for metals in groundwater in basewide hydrogeology wells BH-1, BH-3, BH-4, BH-5, and BH-6. Groundwater was not sampled in BH-2. The table shows that the total recoverable concentrations for many metals exceed the MCL and NAWQC standards discussed in Section 4.1.1. The concentrations of dissolved metals are considerably lower; therefore, the majority of the metals in the groundwater are suspended in solution.

It appears that many of the wells installed during the Stage 3 site investigation were not properly developed prior to sampling for metals. The fact that the large majority of the heavy metals detected in the groundwater are suspended, not dissolved, leads to the conclusion that soil phenomena are the cause of the elevated total recoverable metals concentrations. If the wells were not developed properly, portions of the soils, primarily silts, could remain in suspension and be detected as a constituent of the groundwater. In some cases, it may be impossible to properly develop wells in soils containing fine silts. A well screen with slots small enough to prevent silts from entering the well may not allow water to enter the well either. Therefore, data for total recoverable metals from these wells could be misleading, as the results may represent water mixed with silts, not naturally occurring groundwater. The possibility that this is the cause of the high total recoverable metals values at many of the sites at Elmendorf AFB is supported by the 2 following facts:

- At the basewide hydrogeology well which contained the highest concentrations of metals (BH-3), silt was encountered during installation of the well (Appendix D). If the well was not developed properly prior to sampling, silt may still be mixed with the groundwater. Therefore, some of the silt was sampled as part of the groundwater. Metals in suspension accounted for the vast majority (an average of 99.86 percent) of total metals in this well.

TABLE 4.1.6 HEAVY METALS IN GROUNDWATER IN BASEWIDE HYDROGEOLOGY WELLS

	Total Recoverable			Dissolved		
Metal	Mean (mg/L)	Std. Dev.	Detection Frequency	Mean (mg/L)	Std. Dev.	Detection Frequency
Arsenic	.79	1.7	5/5	.004	NA	1/5
Lead	.69	1.4	5/5	ND	NA	0/5
Mercury	.013	.026	5/5	ND	NA	0/5
Aluminum	1700	3500	5/5	.23	NA	1/5
Barium	8.3	18	5/5	.074	.029	5/5
Beryllium	.094	.11	4/5	ND	NA	0/5
Chromium	4.5	9.8	5/5	ND	NA	0/5
Cobalt	1.5	3.1	5/5	ND	NA	0/5
Copper	4.1	8.4	5/5	.009	NA	1/5
Iron	3500	7500	5/5	.22	.050	2/5
Magnesium	1100	2300	5/5	14	8.8	5/5
Manganese	78	160	5/5	.41	.46	3/5
Molybdenum	1.3	2.5	4/5	.02	NA	1/5
Nickel	5.5	10	4/5	ND	NA	0/5
Silver	.013	NA	1/5	ND	NA	0/5
Zinc	7.0	15	5/5	.037	.021	3/5
Vanadium	5.6	12	5/5	ND	NA	0/5

NA - Not Applicable
ND - Not Detected

- At site IS-1, 2 wells installed during previous site investigations were located in close proximity to a well installed during the Stage 3 site investigation. Dissolved metals concentrations in all 3 wells were similar. However, the new well showed much higher concentrations of total recoverable metals than the older wells, indicating that suspended metals concentrations were much higher in the new well. Again, this is probably due to improper development of the well and the presence of silts in the groundwater sample. Site IS-1 is discussed in detail in Section 4.2.8. This same relationship pertaining to metals data between Stage 3 wells and previous site investigation wells can be seen throughout the base.

Review of literature pertaining to the occurrence of heavy metals in groundwater show that low levels of metals are common constituents of groundwater. Table 4.1.7 provides a summary of typical concentrations of metals in groundwater. In addition to the data provided in this table, it should be noted that iron and manganese naturally occur at high concentrations throughout the Elmendorf area (Glass, USGS, personal communication, 30 June 1989). Comparison of Table 4.1.6 to Table 4.1.7 shows that background metals concentrations of dissolved metals in groundwater at Elmendorf AFB do not exceed those typically found in groundwater.

As with soils, the groundwater quality at the individual sites should be compared to the basewide hydrogeology wells (Table 4.1.6 and Section 4.2.25) and typical metals concentration values from the literature (Table 4.1.7). At the wells installed during Stage 3, only dissolved metals values should be compared. Total recoverable values may only be an indication of the extent of well development, not of actual groundwater quality. Total recoverable metals values from wells installed during Phase

TABLE 4.1.7 CLASSIFICATION OF DISSOLVED INORGANIC CONSTITUENTS IN GROUNDWATER

Major constituents (greater than 5 mg/L)

Bicarbonante	Silicon
Calcium	Sodium
Chloride	Sulfate
Magnesium	Carbonic Acid

Minor constituents (0.01-10.0 mg/L)

Boron	Nitrate
Carbonate	Potassium
Fluoride	Strontium
Iron	

Trace constituents (less than 0.1 mg/L)

Aluminum	Molybdenum
Antimony	Nickel
Arsenic	Phosphate
Barium	Platinum
Beryllium	Radium
Bismuth	Rubidium
Bromide	Ruthenium
Cadmium	Scandium
Cerium	Selenium
Cesium	Silver
Chromium	Thallium
Cobalt	Thorium
Copper	Tin
Gallium	Titanium
Germanium	Tungsten
Gold	Uranium
Indium	Vanadium
Iodide	Ytterbium
Lanthanum	Yttrium
Lead	Zinc
Lithium	
Manganese	Zirconium

SOURCE: Davis and DeWiest, Hydrogeology, 1966.

II site investigations may be used for site characterization. If a specific metal falls outside of the 95 percent confidence interval for the basewide hydrogeology wells, is above the typical values from literature, and, particularly, exceeds ARARs, it warrants further consideration as a product of contamination.

4.1.3 Carcinogen Identification

Several compounds detected at Elmendorf AFB have the potential for causing cancer in humans and animals. Table 4.1.8 lists Elmendorf contaminants and associated EPA weight of evidence ratings. Weight-of-evidence ratings qualify the level of evidence that supports designating a chemical as a human carcinogen and assume ingestion and inhalation as the route of entry into the body. Table 4.1.9 discusses each EPA weight-of-evidence category. Human or animal exposure to the contaminants may or may not produce cancer. Factors such as contaminant does, route or entry, and duration of exposure (acture or chronic) influence whether cancer will occur in humans or animals. The scope of this report does not consider these factors. The source of information for identification of contaminants as carcinogens is EPA Superfund Public Health Evaluation Manual, October 1986.

4.1.4 Prioritization of Sites

Based on the results of the field investigation, each site will be prioritized for further IRP effort. Each site will be placed in 1 of the following 5 categories.

- Sites to be included in the feasibility study.
- Sites given high priority for further investigation.
- Sites given medium priority for further investigation.

TABLE 4.1.8 CANCER CAUSING POTENTIAL OF CONTAMINATION DETECTED AT ELMENDORF AFB

CONTAMINANT	EPA WEIGHT-OF-EVIDENCE
Acenaphthene	@
Acetone	NC
Aldrin	B2
Aluminum	NI
Arsenic	A
Barium	NC
Benzene	A
(a) Benzene hexachloride (BHC)	B2
(d) BHC	C
(g) BHC	B2/C
Benzo(a)anthracene	B2
Benzo(a)pyrene	B2
Benzo(b)fluoranthene	B2
Benzo(k)fluoranthene	D
Beryllium	B1
Bis(2-ethylhexyl) phthalate	B2
2-Butanone	NC
Calcium	NI
Chlorobenzene	NC
Chloroform	B2
4-Chloro-3-methylphenol	NI
2-Chlorophenol	NI
Chromium(VI)	A*
Chrysene	B2
Cobalt	NI
Copper	NC
4,4'-DDD	B2
4,4'-DDT	B2
1,3-Dichlorobenzene	NC
1,4-Dichlorobenzene	NC
Dichlorodifluoromethane	NC
1,1-Dichloroethane	NC
1,2-Dichloroethane	B2
2,6-Dichlorophenol	NI
Dieldrin	B2
Di-n-butyl phthalate	NI
2,4-Dinitrotoluene	B2
Endrin	NI
Ethanol	NC
Ethylbenzene	NC
Fluoranthene	@
Fluoride	NC
Heptachlor	B2
Hexachlorocyclopentadiene	NC

TABLE 4.1.8 (Continued). CANCER CAUSING POTENTIAL OF CONTAMINANTS DETECTED AT ELMENDORF AFB

CONTAMINANT	EPA WEIGHT-OF-EVIDENCE
Hexachloroethane	C
Iron	NC
Lead	NC
Magnesium	NI
Manganese	NC
Mercury	NC
Methylene chloride	B2
2-Methylnapthalene	NI
4-Methyl-2-pentanone	NI
2-Methylphenol	NI
4-Methylphenol	NI
Napthalene	NI
Nickel	A
4-Nitrophenol	NI
4-Nitroso-di-n-propylamine	NI
N-Nitrosodiphenylamine	NI
Pentachlorophenol	D
Phenanthrene	@
Phenol	NC
2-Picoline	NI
Potassium	NI
Pyrene	NI
Sodium	NI
1,2,4,5-Tetrachlorobenzene	NC
1,1,2,2-Tetrachloroethane	C
Tetrachloroethene	B2
Toluene	NC
Total Petroleum Hydrocarbons	NI
1,2,4-Trichlorobenzene	NC
1,1,1-Trichloroethane	NC
Trichloroethene	B2
Trichlorofluoromethane	NC
Vinyl chloride	A
Xylene (All Isomers)	NC

Notes:

- NC Noncarcinogen
- @ Potential Carcinogenic effect
- NI No Information Available
- * Route of entry is based on inhalation only

TABLE 4.1.9 EPA WEIGHT-OF-EVIDENCE CATEGORIES FOR POTENTIAL CARCINOGENS

EPA Category	Description of Group	Description of Evidence
Group A	Human Carcinogen	Sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer
Group B1	Probable Human Carcinogen	Limited evidence of carcinogenicity in humans from epidemiologic studies
Group B2	Probable Human Carcinogen	Sufficient evidence of carcinogenicity in animals, inadequate evidence of carcinogenicity in humans
Group C	Possible Human Carcinogen	Limited evidence of carcinogenicity in animals
Group D	Not Classified	Inadequate evidence of carcinogenicity in animals
Group E	No Evidence of Carcinogenicity in Humans	No evidence of carcinogenicity in at least two adequate animal tests or in both epidemiologic and animal studies

- Sites given low priority for further investigation.

- Sites determined to require no further action.

Sites to be included in the feasibility study meet the following criteria. TPH and/or BETX are present above allowable limits. There is also the potential for offsite of off-Base migration of contaminants.

Sites given high priority for further investigation exhibit potential for off-Base or offsite migration of contamination. Non-carcinogenic contaminants have been detected near or above allowable concentrations. Carcinogens may be detected, but are below allowable concentrations. In general, at sites given medium priority for further investigation, contamination was detected near or slightly above allowable limits. At sites given a low priority for further investigation, contamination was detected below allowable limits. Also, no offsite migration of contamination is expected.

Sites where contamination was not detected or was detected below allowable concentrations were considered for no further action sites. If it was determined that the site posed no threat to human health or the environment, the site was determined to require no further action.

4.2 DISCUSSION OF RESULTS

Results from the 1988 Elmendorf IRP Stage 3 RI/FS field effort are grouped and discussed below by site. Background information on the history, geology, and hydrogeology for each site was obtained from the following reports: Engineering Science 1983, Dames and Moore 1987, and Harding and Lawson 1988. Historical aerial photos from 1950, 1957, 1961, 1965 and 1973, along with Elmendorf AFB plan maps and as-built drawings from 1950 and 1965, were used in the site investigations. Information concerning chemical properties discussed under significance of findings for each site was taken from Sax 1984 and Merck 1983.

Each site is a separate subsection, and all data corresponding to that site are presented. This includes tabulated analytical results, hydrological findings, associated text, and any other pertinent data relating to that specific site. In addition, any problems with sampling and the associated analyses are addressed. The significance of the findings are discussed, and zones of contamination or contaminant migration routes are delineated. Site locations along with sampling points are presented on Drawing No. 13833.130 Sheet 1 of 2 in the folder at the end of this section. Groundwater flow direction at the individual sites was derived from the base hydrogeology map included at the end of this section, Drawing No. 13833.130 Sheet 2 of 2.

Only contaminants that were detected above detection limits are discussed in the text. Data from duplicate samples are not discussed in the text but are presented in the analytical results tables for each site. The analytical results tables are developed so that the wells are presented upgradient to downgradient. Analytical data from past IRP investigations are also included in the analytical tables. Soil data are presented on a dry weight basis. The results of soil analysis as presented in the text and on figures have been rounded to 3 significant figures. All organic results obtained by GC methods which showed a positive result were

confirmed by a second column. During field sampling for dissolved metals, some samples were not filtered in the field. If the sample was not originally filtered and was resampled, the original dissolved metals data is not valid only the resampled dissolved metals data should be used.

Field Quality Control (QC) was maintained by including ambient condition blanks (ACB), equipment blanks (EB), and trip blanks with field samples sent to the laboratory. Appendix G contains the results of these QC samples. As expected, some contamination of the blanks occurred. Toluene and bis(2-ethylhexyl) phthalate were listed in Appendix G as QC contaminants, but could also be present as a result of field work. EB contamination (phenol, total petroleum hydrocarbons, benzene, recoverable lead and iron, etc.) is probably due to residual compounds in sampling equipment following decontamination procedures. The source of additional contamination in the sample blanks is unknown. Field analytical results are not modified as a result of detected compounds in the field QC blank samples.

4.2.1 Discussion of Results for Site D-3, Landfill

The landfill at Site D-3 covers approximately 15 acres and was operated from 1943 to 1957 (Figure 4.2.1.1). The site was primarily used for the disposal of general refuse, construction rubble, small quantities of shop wastes and spent ammunition.

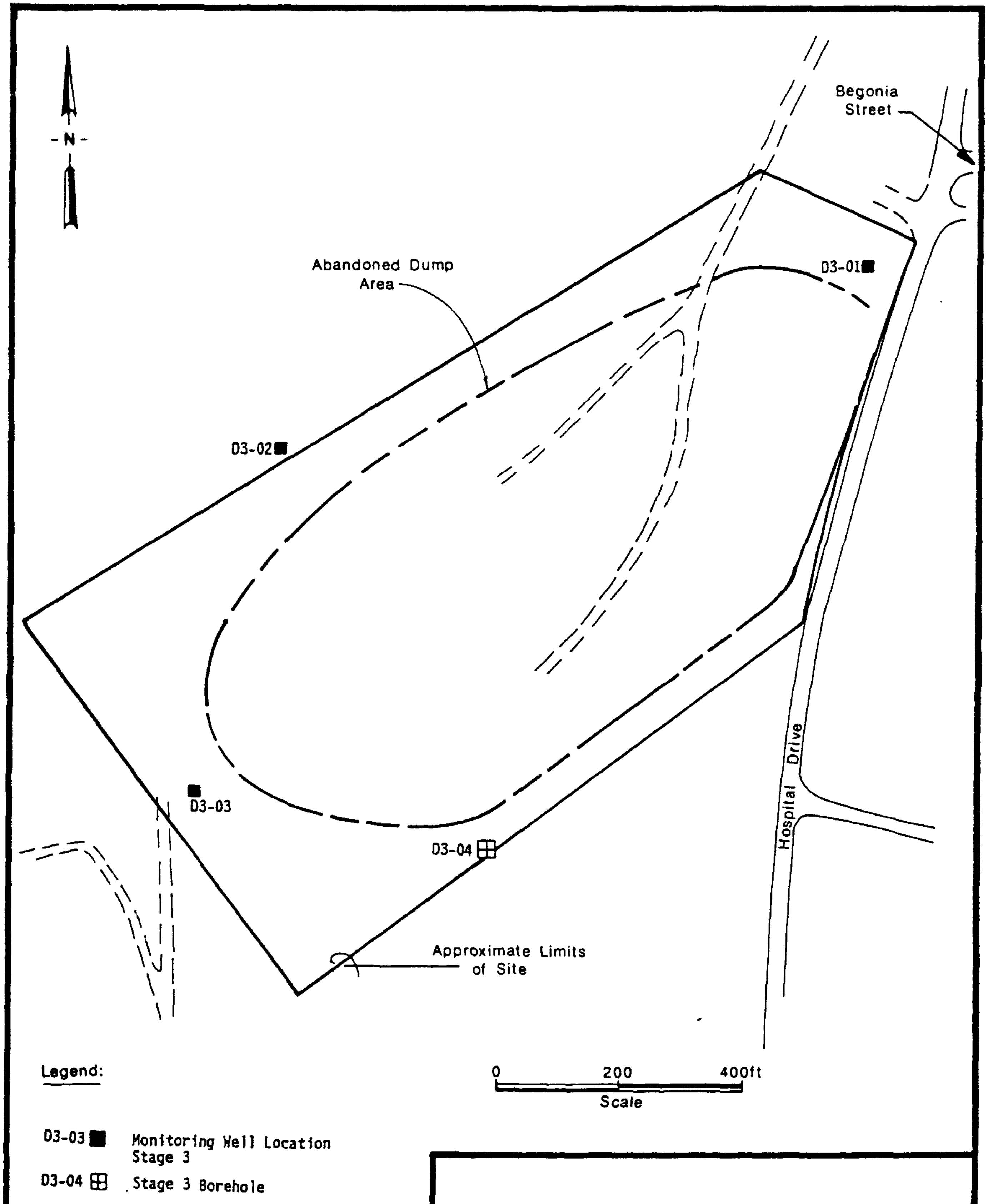
4.2.1.1 Presentation of Results from Site D-3

Results of the geologic and hydrogeologic investigations are presented below. Analytical results are tabulated and presented on site maps.

4.2.1.1.1 Site Geology

The landfill overlies mixed alluvial sediments at an elevation of 210 to 225 feet. The landfill is capped with gravelly clay, the top of which is about 15 feet above the adjacent terrain. The near-surface alluvium typically consists of gravelly sandy silt and grades into a silty sandy gravel. Sand lenses are found at several locations. The surrounding topography is relatively flat, sloping slightly to the west.

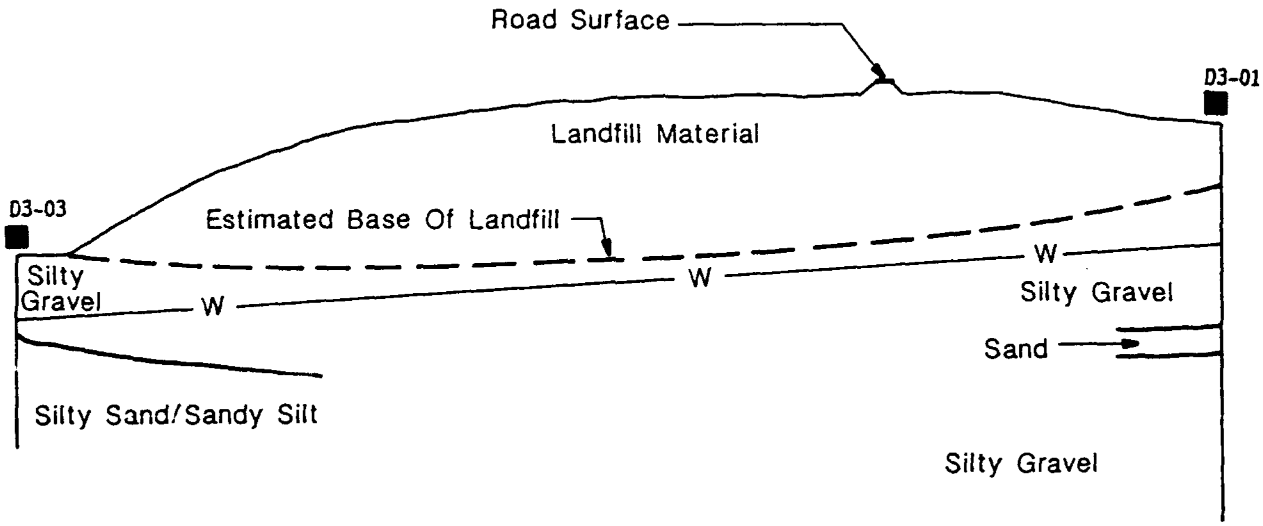
Magnetic, electromagnetic and ground penetrating radar geophysical techniques were used to evaluate subsurface conditions beneath the site. Figure 4.2.1.2 shows a schematic geologic cross section of the site, based on interpretation of geophysical records and test boring data. Historic aerial photos and topographic maps, some dating from 1950 were used in the site investigation. Interpretation of geophysical data, coupled with remote sensing and surface mapping, were used to define the extent of metallic debris within the site. This information was the basis for mapping the landfill boundary. The interpretation of characteristic geophysical data records (signatures) was based on variations in total field proton magnetometer and terrain conductivity data.



LOCATION MAP
SITE D-3

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.1.1

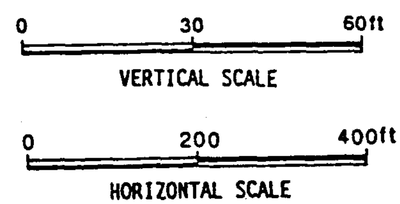


Legend:

D3-03 Monitoring Well Location Stage 3

—W— Projected Water Table

— — — Geologic Contact, Dashed Where Inferred



Notes:

1. Horizontal scale: 1 inch = approximately 200 feet.
2. Vertical scale: 1 inch = 30 feet.
3. Cross section location shown on Figure 4.2.1.3
4. Based on geophysical data interpretation and test borings logs.

GEOLOGIC CROSS SECTION
SITE D-3

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.1.2

4.2.1.1.2 Site Hydrogeology

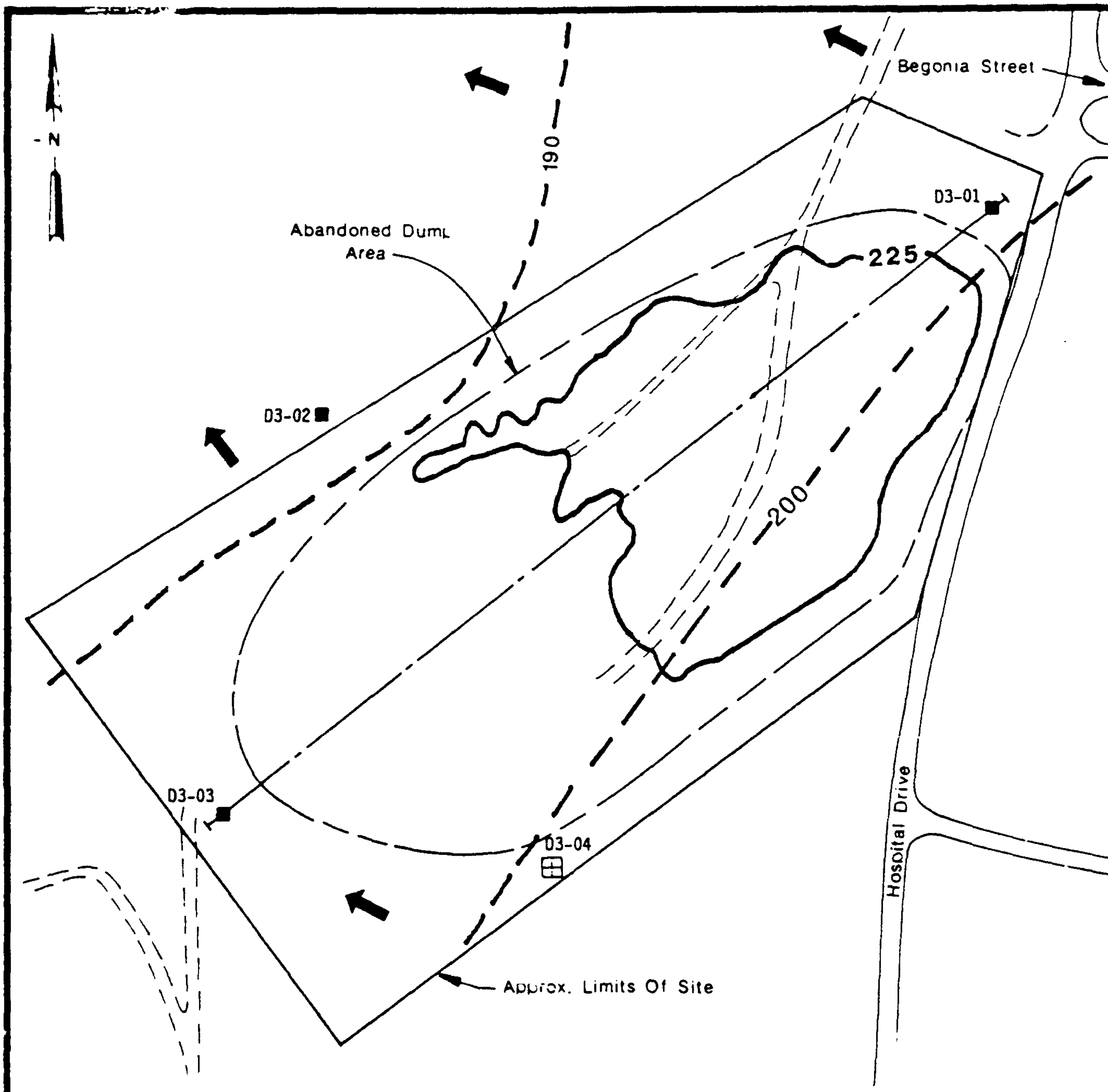
Site D-3 is underlain by gravelly sandy silt, and silty sandy gravel which contain sand lenses. The water table was identified during drilling of test borings in an unconfined aquifer at depths ranging from 10 to 40 feet below the ground surface. Determination of groundwater flow direction was based upon comparison of regional flow trends with water-level elevation measurements made in the 3 monitoring wells at Site D-3 (Figure 4.2.1.3). Based on this information the flow direction is generally west-northwest with a gradient of about 60 to 130 feet per mile. An estimated hydraulic conductivity of 0.24 feet per day in the aquifer was based upon the results of a slug test conducted on well D3-02.

4.2.1.1.3 Analytical Results

Field analytical results, observations and laboratory analytical results are discussed in the following sections.

4.2.1.1.3.1 Field Analytical Results and Observations

Results of a soil gas survey conducted at Site D-3 are presented in Figure 4.2.1.4, and the field data are summarized on Table 4.2.1.1. Isoconcentration contours have been drawn on the basis of the field analysis. Xylene levels to 4.8 ppm and toluene to a concentration of 15.6 ppm were detected in the soil gas survey. During the soil gas survey, unidentified contamination was evident in chromatographic data throughout the site. Peaks of unidentified contaminants appear in chromatographs when calibrated to benzene, toluene, and xylene. The peaks of the unidentified compounds were summarized and reported as "unidentified organic" contamination. This contamination was detected in concentrations up to approximately 0.63 ppm. In addition to the soil gas survey, visual observations were made in the field at all subsurface investigative sites.



Legend:

03-04 Stage 3 Borehole

D3-02 Monitoring Well Location Stage 3

230 Water table contour. Contour intervals: 10ft.

Approximate direction of groundwater flow.

300 Landsurface elevation contour. Contour intervals: 20ft.

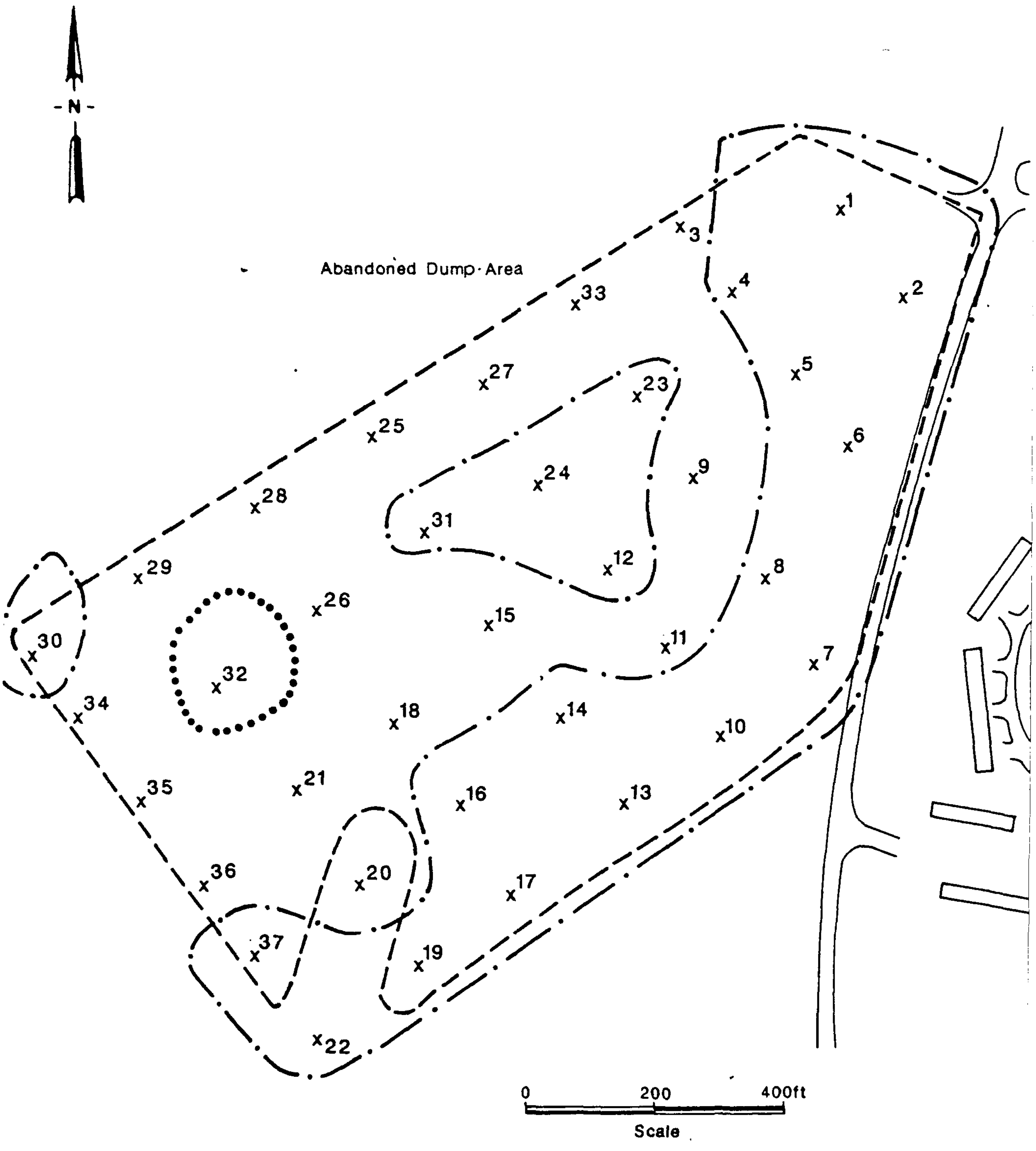
Geologic Cross Section

0 200 400ft
Scale

HYDROGEOLOGIC MAP
SITE D-3

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.1.3



Legend:

—·—·—	Detectable Unidentified Organic Contamination
— — —	Detectable BTX Contamination
●●●●●●	>10ppm BTX Contamination
x8	Probe Location

SOIL GAS SURVEY
LOCATIONS AND RESULTS
SITE D-3

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.1.4

Table 4.2.1.1. Summary of Soil Gas Chromatograph Analyses at Site D-3.

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)	Comments
1	8	-	1.7	1.8	.03	Unidentified organics
2	10	-	2.4	4.8	.15	are at 1.15 RT.
3	5.5	-	.63	.07	TR	
4	5	-	1.2	2.4	.06	
5	2	-	2	6.7	.11	
6	2	.06	-	3.9	.04	
7	8	-	TR	TR	.05	
8	10	-	2.0	.4	.03	
9	8	-	.2	.06	-	
10	7	-	.60	2.0	.09	
11	10	-	.03	.3	-	
12	8	-	TR	.08	.07	
13	5.5	-	1.0	TR	.21	
14	5	-	.1	TR	.10	
15	5	TR	.3	TR	-	
16	2.5	-	-	.4	.12	
17	8.5		.45		.45	
18	10	-	1.2	2.6	-	
19	7	-	TR	-	.12	
20	6.5	-	-	-	-	
21	6	-	1.43	TR	-	
22	7.5	-	-	-	-	
23	10	-	.35	-	.13	
24	6.5	-	.91	-	.04	
25	10	-	2.67	-	-	
26	6.5	-	1.72	-	-	
27	5	-	.67	-	-	
28	6.5	-	.48	-	-	
29	7.5	-	2.61	-	-	
30	10	-	2.45	TR	TR	Water to surface
31	10	-	.83	2.1	.63	
32	8	-	15.6	-	-	
33	5	0	.5	-	-	
34	10	-	1.16	-	-	
35	10	-	.51	TR	-	
36	10	-	.73	TR	-	
37	8	-	.43	.21	.06	

Notes: Unidentified organics are reported in benzene equivalent ppm.
TR - Trace
RT - Retention Time

No indication of contamination was observed at wells D3-01 and D3-03 or boring D3-04. An HNu reading of 1.5 ppm and an odor of organic decay was noticed in a soil sample at 30 feet from well D3-02. Other field parameters measured at Site D-3 during groundwater sampling are presented on Table 4.2.1.2.

4.2.1.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site D-3 is presented on Table 4.2.1.3, and the sample plan for the base-wide field investigation program is included in Appendix B. The only organic contaminant identified from the laboratory analysis, 4-methylphenol was detected in a soil sample taken from boring D3-02, and the concentration is plotted next to D3-02 in Figure 4.2.1.5. Sampling depth is on the figure; however, isoconcentration lines were not drawn due to having only a single point registering a detectable amount of the contaminant

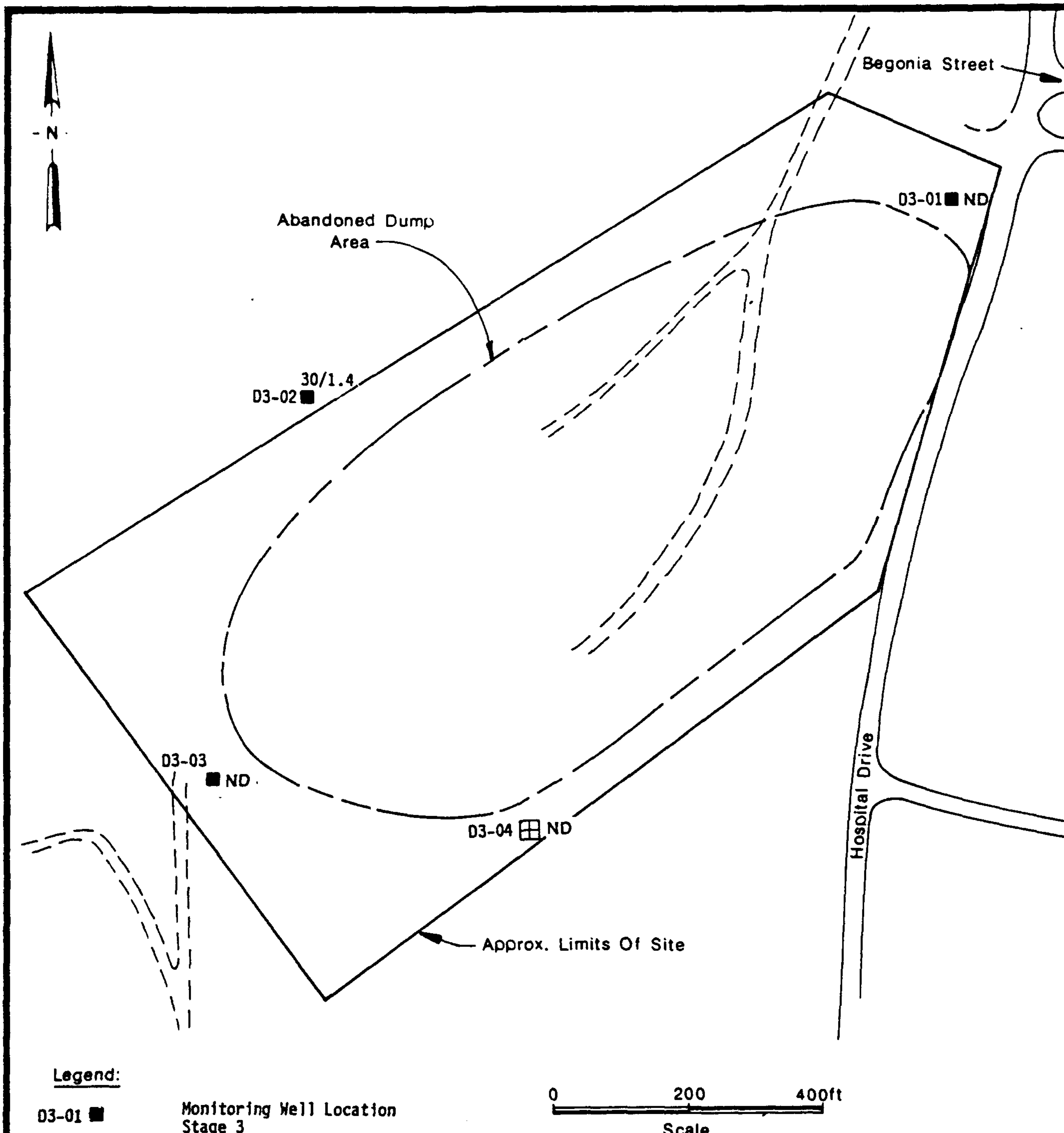
4.2.1.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site D-3 are presented on Table 4.2.1.4.

4.2.1.1.5 Discussion of Analytical Data

Volatile organic compounds were not prevalent at Site D-3. However, the compound 4-methylphenol was detected at a concentration of 1.4 mg/kg in the soil from a depth of 30 feet at well D3-02 at Site D-3. The source of contamination and environmental fate of 4-methylphenol (and the compounds discussed below) is included in Section 4.2.1.3.3.3 - Fate and Transport of Contaminants.

Several metals were detected in the soil samples from the site. The metals detected included aluminum (9410 to 17700 mg/kg), iron (16700 to 33600



Legend:

D3-01 ■ Monitoring Well Location Stage 3

Boring Number
Boring Location
Depth of Sample (ft)
Analyte Concentration

D3-04 ⊞ 10/300

[Soil: mg/kg
Water: µg/L
ND: Non-Detected]

Note: Water sample concentrations not associated with a depth.

4-METHYLPHENOL CONCENTRATION
SITE D-3

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.1.5

Table 4.2.1.2 Groundwater Field Parameters, Site D-3

Well No.	Date Sampled	Temp. (C)	Conductivity (umhos/cm)	pH	Alkalinity (mg/L)	Appearance
D3-1	8/19/88	5.5	140	7.91	92	No odor or sheen
D3-2	8/19/88	5.0	162	7.51	129	No odor or sheen
D3-3	8/19/88	3.5	339	7.54	262	No odor or sheen

Table 4.2.1.3 Requested Analyses for Laboratory Samples at Site D-3

SOIL

Test Number	Analysis
SW3550/E418.1	Total Petroleum Hydrocarbons
SW3050/SW6010	ICP Screen (25 metals)
SW7471	Mercury
SW8240	Volatile Organic Compounds
SW3550/SW8270	Semi-Volatile Organic Compounds
D2216 (E160.3)	Soil Moisture Content

WATER

Test Number	Analysis
E300	Common Anions
E418.1	Petroleum Hydrocarbons
SW3005/SW6010	ICP Screen (total and dissolved)
SW7060	Arsenic (total and dissolved)
SW3005/SW7427	Lead (total and dissolved)
SW7470	Mercury (total and dissolved)
SW7740	Selenium (total and dissolved)
SW5030/SW8010	Purgeable Halocarbons
SW5030/SW8020	Purgeable Aromatics
SW3510/SW8270	Extractable Priority Pollutants

Table 4.2.1.4

Analytical Results - Site D-3

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	D3-03 0'-1.5' 0687-SO-003 GS-88-01 000774-0001	D3-03 15'-16.5' 0687-SO-003 GS-88-02 000774-0002	D3-02 0687-NG-002 GN-88-0003 001324-0003	D3-02 10'-11.5' 0687-SO-002 GS-88-0001 000768-0001	D3-02 30'-31.5' 0687-SO-002 GS-88-0002 000768-0002
4-Methylphenol	Method 8270	mg/kg						1.4
Aluminum	6010	mg/kg		19490	9389		12224	9410
Barium	6010	mg/kg		73	42		36	31
Beryllium	6010	mg/kg		0.4	0.2		0.2	0.1
Calcium	6010	mg/kg		3949	8258		6497	7937
Chloride	300.0	mg/L	250			1.1		
Chromium	6010	mg/kg	50,000	25	23		23	20
Cobalt	6010	mg/kg		10	7		8	7
Copper	6010	mg/kg	1,850	15	12		19	14
Dissolved Arsenic	206.2	mg/L	0.05			0.005		
Dissolved Barium	200.7	mg/L	1.0			0.13		
Dissolved Calcium	200.7	mg/L				38.		
Dissolved Magnesium	200.7	mg/L				9.6		
Dissolved Manganese	200.7	mg/L	0.05			0.20		
Dissolved Selenium	270.2	mg/L	0.01			0.002		
Dissolved Sodium	200.7	mg/L	250			9.5		
Iron	6010	mg/kg		26752	16742		20484	17234
Lead	6010	mg/kg	70	9			7	
Magnesium	6010	mg/kg		4968	7353		6828	6349
Manganese	6010	mg/kg	11,000	484	339		441	385
Mercury	7471	mg/kg	100	0.09				
Nickel	6010	mg/kg	500	23	26		30	24
Potassium	6010	mg/kg					661	
Recoverable Aluminum	200.7	mg/L				29.		
Recoverable Arsenic	206.2	mg/L	0.05			0.010		
Recoverable Barium	200.7	mg/L	1.0			0.18		
Recoverable Calcium	200.7	mg/L				66.		
Recoverable Chromium	200.7	mg/L	0.05			0.04		
Recoverable Cobalt	200.7	mg/L				0.02		
Recoverable Copper	200.7	mg/L	1.0			0.063		
Recoverable Iron	200.7	mg/L	0.3			45.		
Recoverable Lead	239.2	mg/L	0.05			0.019		
Recoverable Magnesium	200.7	mg/L				25.		
Recoverable Manganese	200.7	mg/L	0.05			1.3		
Recoverable Nickel	200.7	mg/L				0.08		
Recoverable Sodium	200.7	mg/L	250			7.0		
Recoverable Vanadium	200.7	mg/L				0.08		
Recoverable Zinc	200.7	mg/L	5.0			0.14		
Sodium	6010	mg/kg		140	158		121	125
Sulfate	300.0	mg/L	250			7.3		
Total Dissolved Solids	160.2							
Total Mercury	245.1	mg/L	0.002			0.0002		
Total Solids	160.3	%		78.5	88.4	0.0004	90.8	88.2
Vanadium	6010	mg/kg	1,000	64	34		41	32
Zinc	6010	mg/kg	10,500	39	33		42	34

Table 4.2.1.4

Analytical Results - Site D-3

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	D3-04 5'-6.5' 0687-SO-004 GS-88-0001 000805-0001	D3-04 30'-31.5' 0687-SO-004 GS-88-0002 000805-0002	D3-01 0687-NG-001 GN-88-0003 001324-0005	D3-01 30'-31.5' 0687-SO-001 GS-88-0001 000768-0003	D3-01 50'-51.5' 0687-SO-001 GS-88-0002 000768-0004	D3-03 0687-NG-003 GN-88-0003 001324-0002
4-Methylphenol	Method 8270	mg/kg							
Aluminum	6010	mg/kg		17711	10789		11084	12542	
Barium	6010	mg/kg		61	46		28	51	
Beryllium	6010	mg/kg		0.4	0.2		0.2	0.2	
Calcium	6010	mg/kg		4578	10093		7186	9718	
Chloride	300.0	mg/L	250			9.0			9.1
Chromium	6010	mg/kg	50,000	34	20		27	25	
Cobalt	6010	mg/kg		13	7		7	8	
Copper	6010	mg/kg	1,850	31	15		13	18	
Dissolved Arsenic	206.2	mg/L	0.05						
Dissolved Barium	200.7	mg/L	1.0			0.011			0.033
Dissolved Calcium	200.7	mg/L				30.			87.
Dissolved Magnesium	200.7	mg/L				6.5			20.
Dissolved Manganese	200.7	mg/L	0.05			0.14			0.91
Dissolved Selenium	270.2	mg/L	0.01						0.002
Dissolved Sodium	200.7	mg/L	250			4.4			9.9
Iron	6010	mg/kg		33614	18910		18758	21469	
Lead	6010	mg/kg	70	7				7	
Magnesium	6010	mg/kg		11084	7309		7430	7005	
Manganese	6010	mg/kg	11,000	566	418		378	463	
Mercury	7471	mg/kg	100	0.06					
Nickel	6010	mg/kg	500	36	21		29	26	
Potassium	6010	mg/kg		819	754			791	
Recoverable Aluminum	200.7	mg/L				2.4			1.9
Recoverable Arsenic	206.2	mg/L	0.05			0.003			0.006
Recoverable Barium	200.7	mg/L	1.0			0.027			0.044
Recoverable Calcium	200.7	mg/L				32.			87.
Recoverable Chromium	200.7	mg/L	0.05						
Recoverable Cobalt	200.7	mg/L							
Recoverable Copper	200.7	mg/L	1.0			0.008			
Recoverable Iron	200.7	mg/L	0.3			3.9			3.1
Recoverable Lead	239.2	mg/L	0.05			0.003			0.002
Recoverable Magnesium	200.7	mg/L				7.3			21.
Recoverable Manganese	200.7	mg/L	0.05			0.24			0.93
Recoverable Nickel	200.7	mg/L							
Recoverable Sodium	200.7	mg/L	250			3.6			8.6
Recoverable Vanadium	200.7	mg/L							
Recoverable Zinc	200.7	mg/L	5.0			0.02			0.01
Sodium	6010	mg/kg		133	151		122	147	
Sulfate	300.0	mg/L	250			14			34.
Total Dissolved Solids	160.2					170			
Total Mercury	245.1	mg/L	0.002						
Total Solids	160.3	%		83.0	86.2		82.1	88.5	
Vanadium	6010	mg/kg	1,000	63	36		40	42	
Zinc	6010	mg/kg	10,500	70	37		34	47	

mg/kg), manganese (340 to 570 mg/kg) and magnesium (4970 to 11100 mg/kg). Water samples also contained these metals at total recoverable concentrations as high as 29, 45, 1.3 and 25 mg/L, respectively. Concentrations of these metals may be related to the distribution of natural minerals in the soils of the area, although the high concentrations indicate contamination is occurring. Dissolved concentrations ranged from 20 mg/L of magnesium to 0.91 mg/L of manganese. High calcium levels in soil samples (3950 to 10100 mg/kg) and water samples (32 to 87 mg/L-recoverable), sodium levels in soil samples (120 to 160 mg/kg) and water samples (3.6 to 8.6 mg/L-recoverable), and potassium levels in soil samples (660 to 820 mg/kg) are also due to the natural mineral content of the surrounding soils.

Sulfate and chloride ions were detected in water samples from wells D3-02 and D3-03 at concentrations ranging from 7.3 to 34 mg/L and 1.1 to 9.1 mg/L, respectively.

Concentrations at less than 70 mg/kg of other elements such as barium, chromium, copper, nickel, vanadium and zinc were detected in soil samples from all borings. Water samples from wells D3-01 and D3-03 contained barium, copper, and zinc, of the above listed elements, at total concentrations less than 0.05 mg/L. A water sample from well D3-02 contained all of the above elements in their total recoverable form at levels ranging from chromium at 0.04 mg/L to barium at 0.18 mg/L. Dissolved barium concentrations in the 3 wells ranged from .011 to 0.13 mg/L.

Cobalt and lead were detected in soil samples at all borings ranging from 6.8 to 13.3 mg/kg and 6.6 to 8.9 mg/kg, respectively. Beryllium was detected in soil samples from all boring at levels ranging from 0.11 to 0.38 mg/kg. Mercury was detected in soil samples from well D3-03 and boring D3-04 at concentrations of 0.09 and 0.06 mg/kg, respectively. Water

samples from all 3 wells contained trace amounts of total recoverable lead (less than 0.02 mg/L) and total recoverable and dissolved arsenic (less than 0.01 mg/L). Dissolved arsenic was detected in well D3-02 at 0.005 mg/L. Total cobalt (0.02 mg/L) and total mercury (0.0004 mg/L) were detected in water from well D3-02 and dissolved selenium was detected in water from both wells D3-02 and D3-03 at a concentration of 0.002 mg/L.

4.2.1.2 Sampling or Analytical Problems

Sampling and analytical problems discussed below include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.1.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis were lost from Site D-3.

4.2.1.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely, that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. In addition, no compounds usually associated with laboratory clean-up procedures were detected in samples from site D-3.

4.2.1.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Eight soil samples were collected from the 3 wells and the test boring at the site. One water sample was collected from each of the 3 wells. No deviations from the work plan occurred at Site D-3.

4.2.1.3 Significance of Findings at Site D-3

Analytical results for samples from Site D-3 showed contamination by various metals (see Section 4.2.1.1.5). These metals were detected in both soil and water samples. Concentrations of dissolved manganese detected in water samples exceed current State of Alaska secondary standards for groundwater contamination and EPA secondary Maximum Contaminant Levels (MCL's) of 0.05 mg/L under the Safe Drinking Water Act. These standards are not enforceable and serve only as guidelines for the aesthetic quality of drinking water. Site specific parameters for soil contamination by metals is not currently part of the State of Alaska Administrative Code, nor are metals regulated by the EPA.

The concentrations of iron and manganese are probably naturally occurring. Manganese falls within the range of concentrations of the basewide hydrogeology (background) wells. Iron falls outside the background wells' range, but is known to occur at high concentrations in the Elmendorf area (Glass, USGS, personal communication, 05 July 1989). Both metals were detected in the soils at concentrations similar to background. However, it is possible that steel and iron debris buried in the landfill may be contributing to the iron concentrations in the groundwater. Basic receptors are humans, wildlife, and plants. Pathways of exposure to the receptors of these metals include ingestion of ground and surface water by humans and wildlife and uptake by plants.

4-methylphenol was detected in soil at D3-02 at a low concentration (1.4 mg/kg), which does not exceed any soil standards or guidelines.

4.2.1.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. A soil gas survey at Site D-3 showed detectable BTX and

unidentified organics contamination throughout the site (Figure 4.2.1.4, Table 4.2.1.1). However, this contamination was not detected by HNu equipment (portable air monitoring) in the field nor was it confirmed by laboratory analysis of samples. General isoconcentration lines have been constructed for the soil gas data, but there is insufficient data from other sources to allow three-dimensional temporal or higher-definition spatial mapping.

Dissolved manganese concentrations were found to be the highest in well D3-03 and lowest in well D3-01. The concentrations of dissolved manganese exceeded State of Alaska and EPA secondary drinking water standards in all 3 sampling locations.

4-methyphenol was detected in soils from D3-02, a downgradient boring.

4.2.1.3.2 Contaminant Migration

The primary migration medium at Site D-3 is groundwater. Surface water could be another migration medium, should contamination reach Ship Creek located less than 1 mile to the north. There is no evidence of migration of contaminants.

The soil gas survey did not extend offsite and results of the soil gas survey could not be used to delineate offsite migration of the BTX and unidentified organic contamination.

4.2.1.3.2.1 Potential for Offsite and Off-Base Migration

Offsite migration is not occurring at Site D-3. Well D3-02 is located downgradient and outside of the site perimeter and has exhibited no obvious evidence of contamination.

4.2.1.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site identified the direction of groundwater flow to be the west-northwest, with a gradient of about 60 to 130 feet per mile. The hydraulic conductivity in the area was estimated to be 0.24 feet per day. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of migration rate of these dissolved metals.

4.2.1.3.2.3 Time of Travel to Receptors

Primary receptors are humans, plants, and wildlife. The primary pathway is through contaminated groundwater and possibly surface waters. A downgradient active Base Well 50 is located about 2400 feet from Site D-3 at the BLM building off Oil Well Road. Ship Creek is located about 3200 feet northwest of the site. Given the estimated groundwater migration route at the site, time of travel to these exposure routes is about 250 to 300 years. Given these estimated travel times, contamination probably has not reached the well and creek.

4.2.1.3.2.4 Applicability of Solute Transport Models

The applicability of solute transport models at Site D-3 cannot be determined by this study due to the need for more information from downgradient wells. Wells installed to the north and northwest of the site and additional hydrogeological data would provide useful information and more accurate solute transport models. The results from this modeling would help to determine the potential risk of contamination for downgradient water supplies and surface water.

4.2.1.3.2.5 Expected Spatial and Temporal Variations in Concentration

There is no evidence that the spatial extent of contamination has reached past the site boundaries. Should contamination have reached Ship Creek water, spatial transport would be increased, but concentrations would be highly diluted by the creek water.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of contaminants is also affected by changes in water pH and temperature which may occur on a seasonal basis.

4.2.1.3.3 Baseline Risk Assessment

The contamination in relation to exposure pathways and effects on receptors are discussed in the following sections.

4.2.1.3.3.1 Waste Characterization

The potential contaminants at this site are manganese and iron dissolved in the groundwater. Both manganese and iron are used in the manufacture of steel and other metal alloys. The central nervous system is the chief site of damage by these metals. However, the toxicity of these metals is very low and health problems only exist at levels much higher than the State of Alaska Secondary Standards (18 AAC 80.060).

BTX and unidentified organics contamination delineated by the soil gas survey were not confirmed by laboratory testing of samples. However, the

presence of these compounds at low levels or as vapors cannot be entirely refuted. Benzene is the most toxic of the BTX compounds and is a known carcinogen.

4.2.1.3.3.2 Source and Release Characterization

Materials buried in the landfill constitute the most likely potential source of contamination at the site. Manganese and iron anions may be entering the groundwater from steel and metal alloy wastes.

BTX and unidentified organic contamination delineated by the soil gas survey may have been introduced to the environment through the burial of shop wastes, small quantities of fuel, and other wastes that were probably unregulated and undocumented. 4-methylphenol may originate from the same sources.

4.2.1.3.3.3 Fate and Transport of Contaminants

The fate of organic compounds released to the environment at Site D-3 includes long-term natural degradation (measured in hundreds of years), dispersion of the contaminants through surface runoff and groundwater, or uptake by living organisms. Another possible fate is the volatilization of compounds that have vapor pressures greater than 1 mm of Hg. The fate of metals in the environment includes oxidation and/or chelation by water or cations such as Cl^- and OH^-. Metals may have leached into the water from steel scrap buried at Site D-3. These anions may then have become adsorbed onto soil particles, remaining bound until conditions (pH and temperature) allow the anions to dissolve into interstitial water, which eventually percolates to the saturation groundwater zone. Any dissolved solvents or BTX compounds from shop wastes would also percolate downward. At the water table, nonsoluable contaminants are able to migrate along the

hydrogeological gradient. Dissolved contaminants can flow with the groundwater through the process of advection.

The source of the solvent 4-methylphenol is unknown; however, there are several industrial uses for the compound as a mixture of the isomers known as cresol (p-, o-, and m- isomers) are used to manufacture the following compounds: synthetic resins, disinfectant, fumigant, photographic developers, and explosives. These products could have been used at Elmendorf AFB; however, no specific use has been identified. 4-methylphenol is a severe skin and eye irritant and has demonstrated a high oral toxicity and moderate dermal toxicity in laboratory animals. Based on soil concentrations and water solubility (2.5% in 50 degree F water), 4-methylphenol will dissolve into infiltrating groundwater at concentrations below the analytical detection limits and will slowly degrade into the vadose zone. 4-Methylphenol is less volatile than water and will not transport long distances by vaporization.

The transport rate in the area is estimated at 0.24 feet per day, but plume dimensions and precise direction of contamination migration are not known for this site.

Any contamination reaching Ship Creek is expected to be highly diluted by the volume and flow rate of this stream. The drinking water well at the BLM building (Base well 50) was last tested for metals in 1987. It was not tested for volatile organic compounds at that time. All metals, except zinc and sodium, were detected at less than 0.1 mg/L (the detection limit of the metals test performed). Water quality exceeds the secondary State of Alaska water quality requirements for manganese.

4.2.1.3.3.4 Exposure Pathways

The primary pathways of exposure to human receptors are ingestion of, or contact with contaminated groundwater, surface water, plants or wildlife.

4.2.1.3.3.5 Identification of Receptors

Human receptors include anyone drinking from the active well in the area (Base well 50) if it is now contaminated. In addition, the water of Ship Creek may be used by humans for drinking or recreation, and for a salmon hatchery adjacent to the base.

Wildlife may be exposed through the ingestion of contaminated surface water in Ship Creek or contaminated vegetation in the vicinity of the creek. Fishing for trout is allowed in Ship Creek, and secondary human exposure through ingestion of fish, berries or other plants may occur.

4.2.1.3.3.6 Threat to Human Health

The most significant threat to human health is the drinking of water from Base Well 50 at the BLM building, should contamination be present in this well. An additional threat would be through the water of Ship Creek, if found to be contaminated in this area. However, this threat is slight due to the low toxicity of iron and manganese.

4.2.1.3.3.7 Carcinogenetic Risks

Benzene is a known human carcinogen and was detected during a soil gas survey conducted at the site. An area of total BTX concentration as high as 15.6 ppm was identified by the soil gas survey. The presence of benzene was not confirmed by laboratory analyses of soil and water samples. There are no standards for soil gas vapor concentrations.

4.2.1.3.3.8 Threat to Wildlife

The primary area in which wildlife could be exposed is in Ship Creek, about 3200 feet northwest of the site. However, contamination of the creek water by sources identified at Site D-3 has not been confirmed. Any contamination migrating to the creek is expected to be greatly diluted and the threat to wildlife from contamination at the site is assessed as low.

4.2.1.3.3.9 No Threat to Health

Groundwater samples collected in 1988 were not contaminated above State of Alaska primary standards for organic compounds and/or metals. Dissolved manganese was detected at levels above State of Alaska secondary standards. However, these standards are not enforceable, and the levels detected are within expected variations of background concentrations. Although they are environmentally persistent, the metals are not considered to be highly toxic. Receptors and pathways of exposure are present, but the duration and frequency of exposure is not expected to be sufficient to cause adverse health effects.

4.2.1.4 Prioritization of Sites for Remedial Alternatives

The site has been adequately characterized by the installation and sampling of 3 monitoring wells and 1 test boring. Site geophysics and the presence of surface debris show the placement of well D3-01 to be in position to sample groundwater within the landfill. Well D3-02 is located at a point outside and downgradient of the site. Well D3-03 is also outside of the assumed landfill boundary, but is not directly downgradient of the landfill in terms of groundwater flow direction. Groundwater samples from these wells were not contaminated at levels above primary State of Alaska standards. Release mechanisms and migration pathways have not been shown to be significant. Therefore, Site D-3 is assigned no further action status.

4.2.2 Discussion of Results for Site D-5, Landfill

General refuse, scrap metal, spent chemicals, and construction rubble were buried at Site D-5 (Figure 4.2.2.1) over the period 1951 through 1973 (Engineering Science 1983). The exact boundaries of the landfill are unknown, but previous studies indicate that an area encompassing 17 acres has been used for landfill purposes at various times. A portion of the site is presently being used for a gravel extraction operation. The gravel operation has expanded and has to date destroyed 5 monitoring wells: W-2, D13-02, D13-03, GW-1C, and GW-1B.

4.2.2.1 Presentation of Results from Site D-5

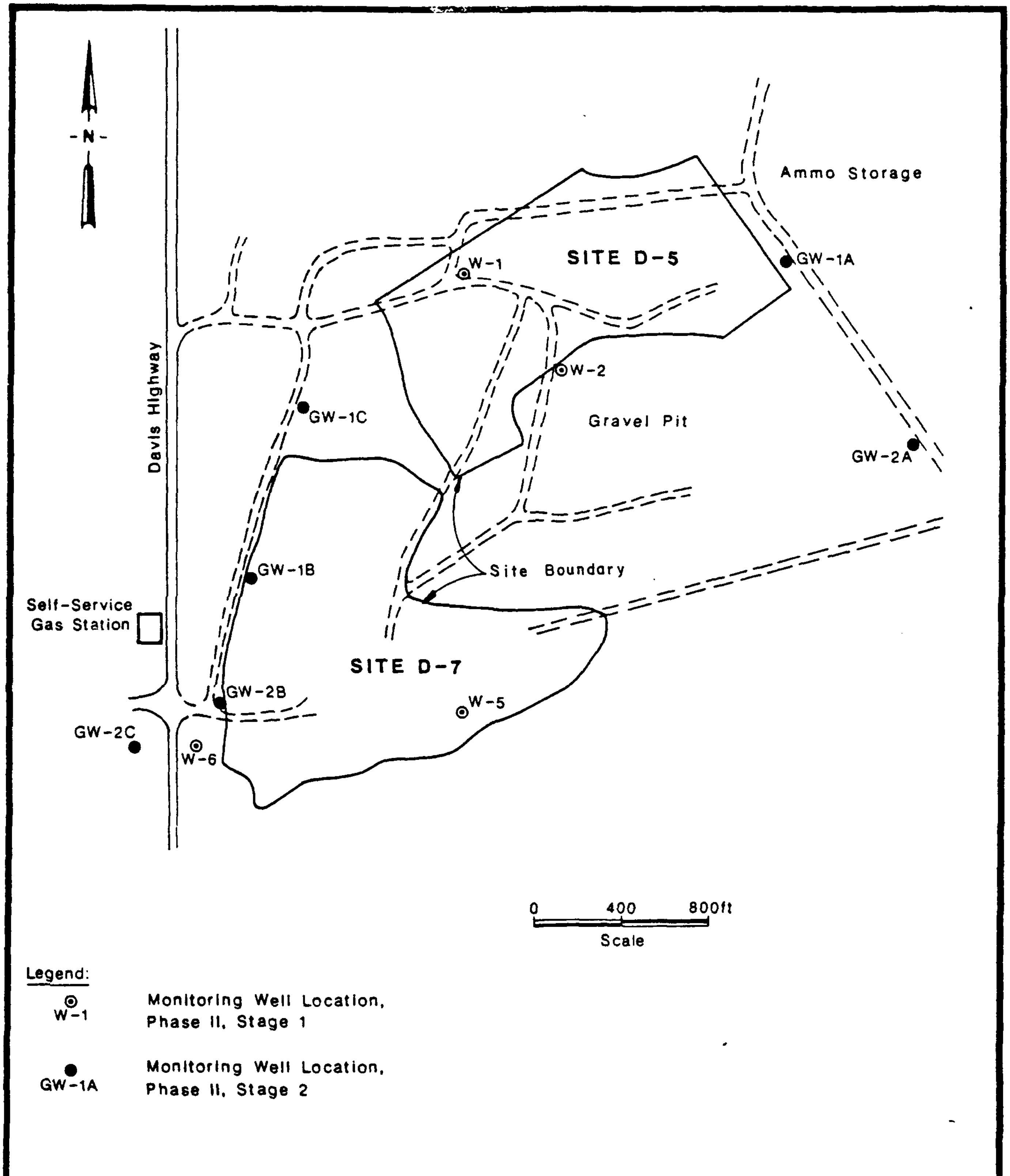
Results of the geologic and hydrogeologic investigations are presented below. Analytical results are tabulated and presented on the site maps.

4.2.2.1.1 Site Geology

Site D-5 is located at an elevation of about 215 feet on late-Quaternary, mostly sandy, glacial outwash deposits. The site surface has been modified by excavation for a gravel pit. The surface of the site has some visible debris. Grass, alder and willow comprise most of the vegetation at the site margins. A schematic geologic cross section is presented in Figure 4.2.2.2.

4.2.2.1.2 Site Hydrogeology

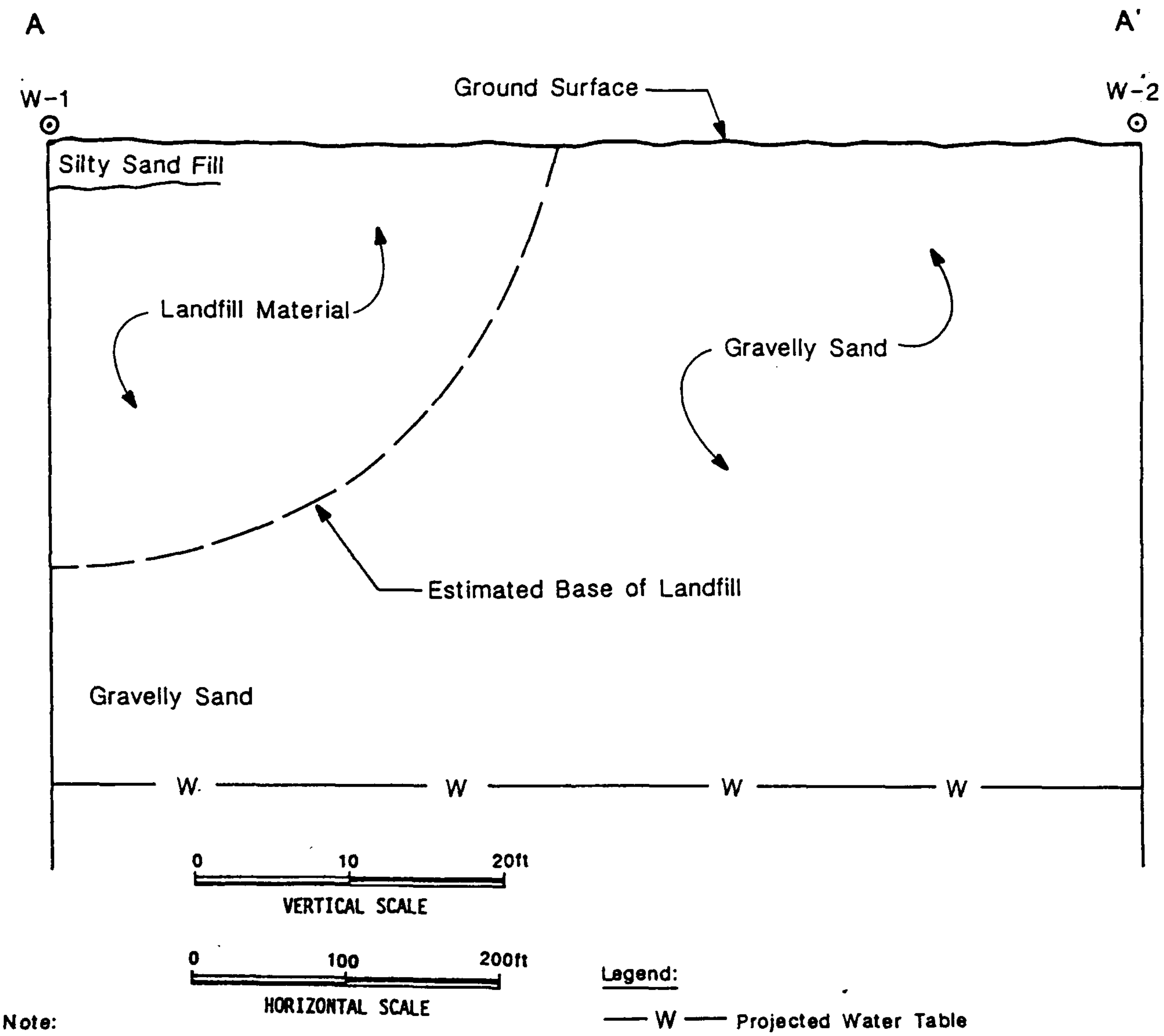
Site D-5 is underlain by sands with some gravel with a water table depth of approximately 30 feet. The direction of groundwater flow, based on a comparison of regional trends with water level measurements at 13 wells (Figure 4.2.2.3), is west-northwest with a gradient of approximately 20 feet per mile. The site is located less than 0.5 mile downgradient from Ship Creek. Ship Creek loses water to the groundwater system in this area.



LOCATION MAP
SITE D-5

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.2.1



Legend:

—— W —— Projected Water Table

W-1 ⊙ Monitoring Well Location Phase II, Stage 1.

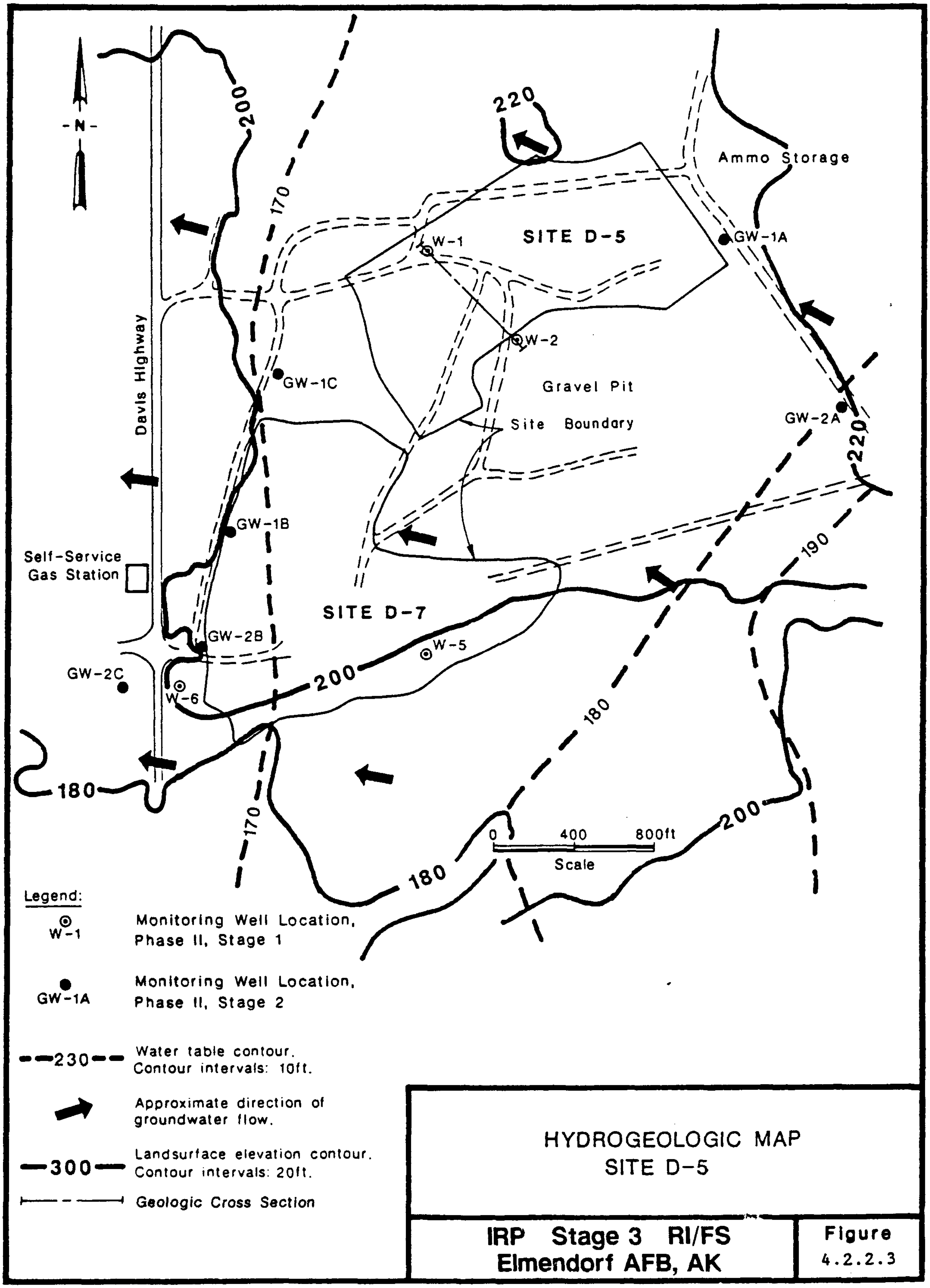
Note:

1. Horizonatal Scale 1 inch = 100 feet
2. Vertical Scale 1 inch = 10 feet.
3. Location of Cross Section shown on Figure 4.2.2.3

GEOLOGIC CROSS SECTION
SITE D-5

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.2.2



HYDROGEOLOGIC MAP
SITE D-5

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.2.3

Four slug tests were conducted in the area and water levels were observed to respond too rapidly for analysis by the slug test methodology. This indicates that the magnitude of hydraulic conductivity across the site is consistent with the area of a pump test (Section 4.2.26). Hydraulic conductivity values have not yet been estimated for this site.

4.2.2.1.3 Analytical Results

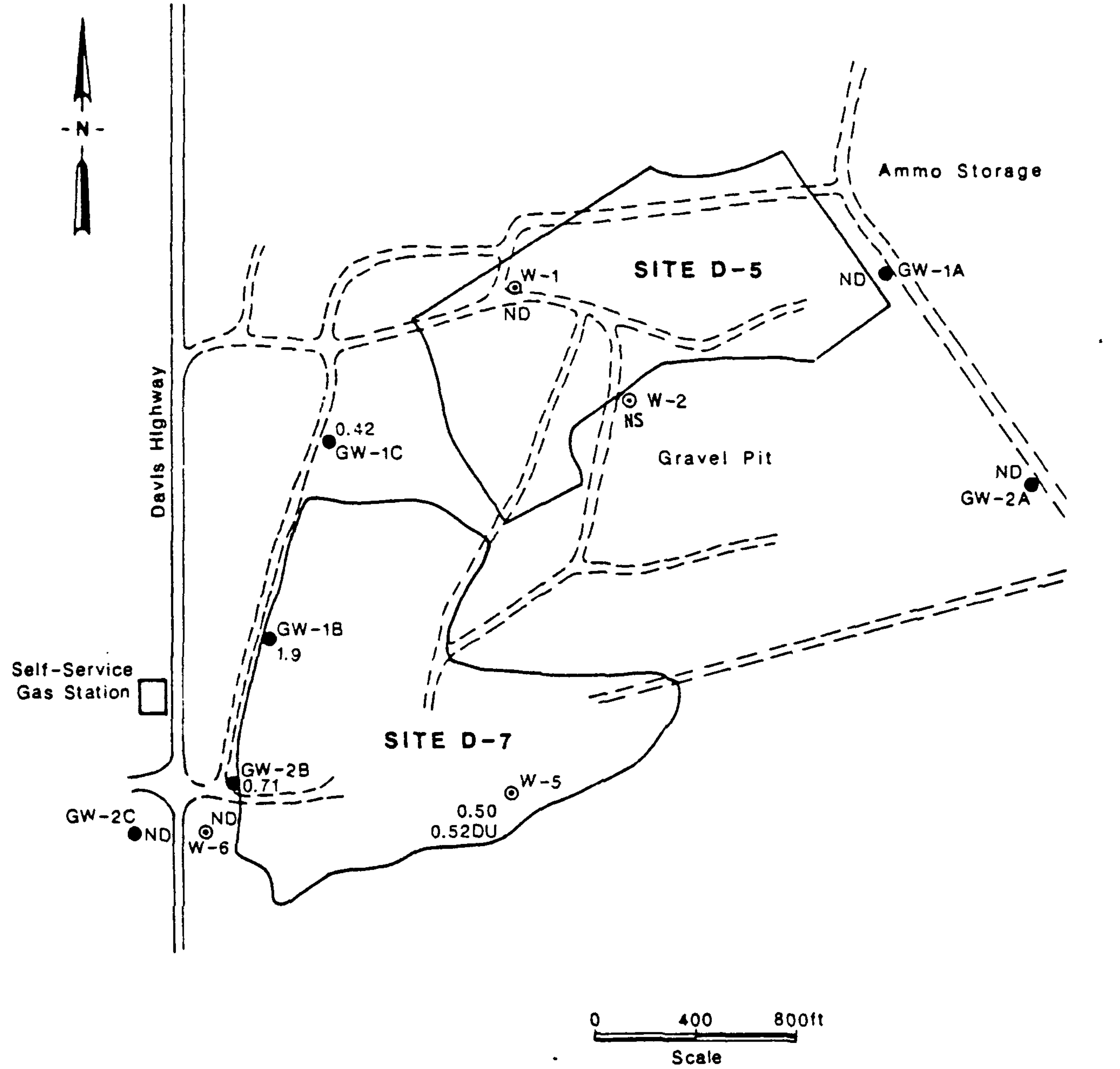
Field analytical results, observations, and laboratory analytical results are discussed in the following sections.

4.2.2.1.3.1 Field Analytical Results and Observations

All field activities at Site D-5 were conducted at existing monitoring wells. The activities consisted of groundwater sampling and performance of slug tests. Well W-2 had been destroyed by gravel extraction activities. Field parameters measured at Site D-5 during groundwater sampling are presented on Table 4.2.2.1.

4.2.2.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site D-5 is presented on Table 4.2.2.2, and the sample plan for the base-wide field investigation program is included in Appendix B. Major organic contaminants identified from the laboratory analysis of samples collected at Site D-5 are plotted in Figures 4.2.2.4 through 4.2.2.7. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations detected in the water samples are plotted next to the corresponding well. Isoconcentration lines were not drawn due to the relatively few points having detectable contamination for each analyte. Results of analytical tests at Site D-5 are presented on Table 4.2.2.3.



Legend:

W-1 — Monitoring Well Location, Phase II, Stage 1

GW-1A — Monitoring Well Location, Phase II, Stage 2

W-2 (Symbol) 10/300

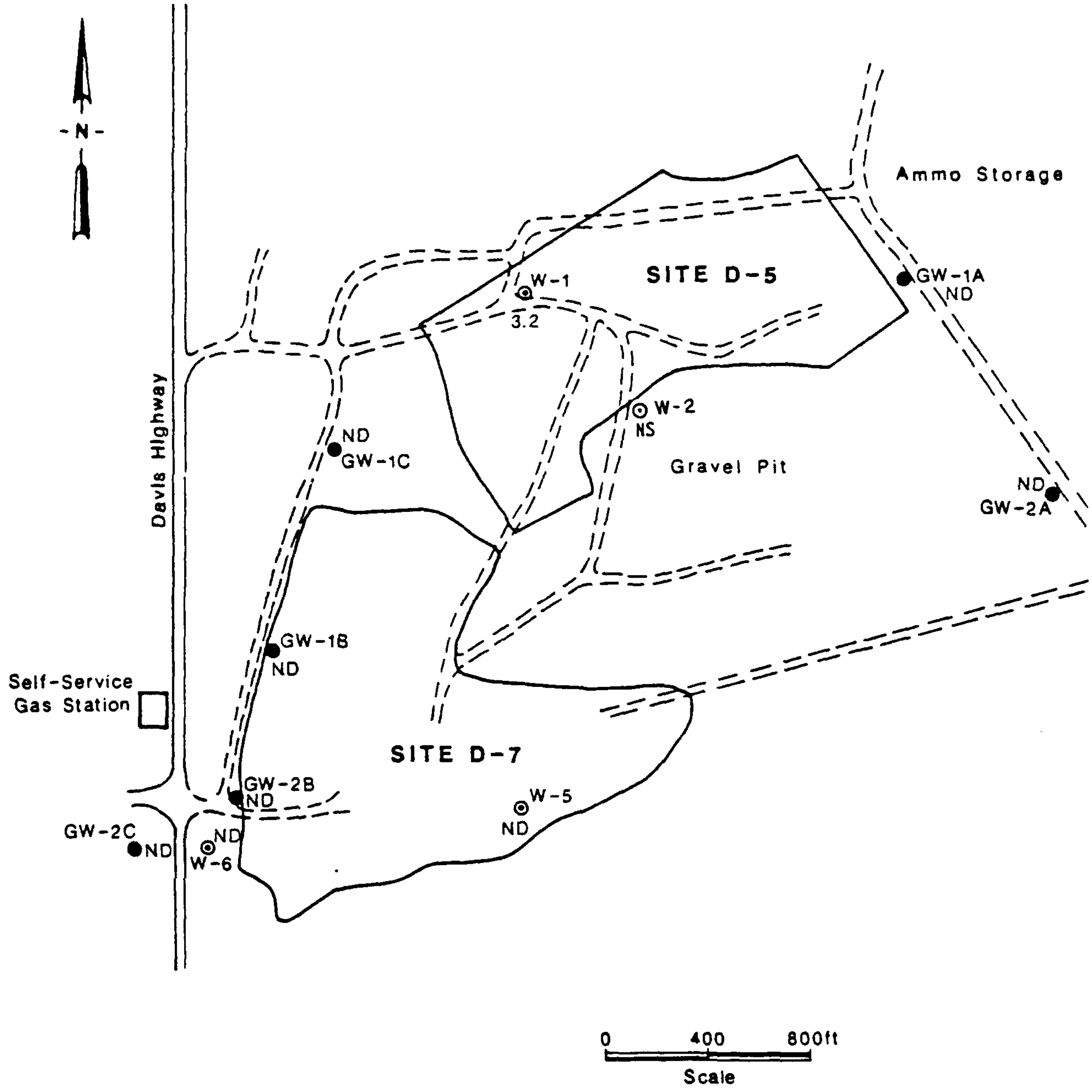
- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration

Water, µg/L
ND: Non-Detected
DU: Duplicate
NS: Not Sampled

TETRACHLOROETHENE
CONCENTRATION
SITE D-5

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.2.4



Legend:

W-1 — Monitoring Well Location, Phase II, Stage 1

GW-1A — Monitoring Well Location, Phase II, Stage 2

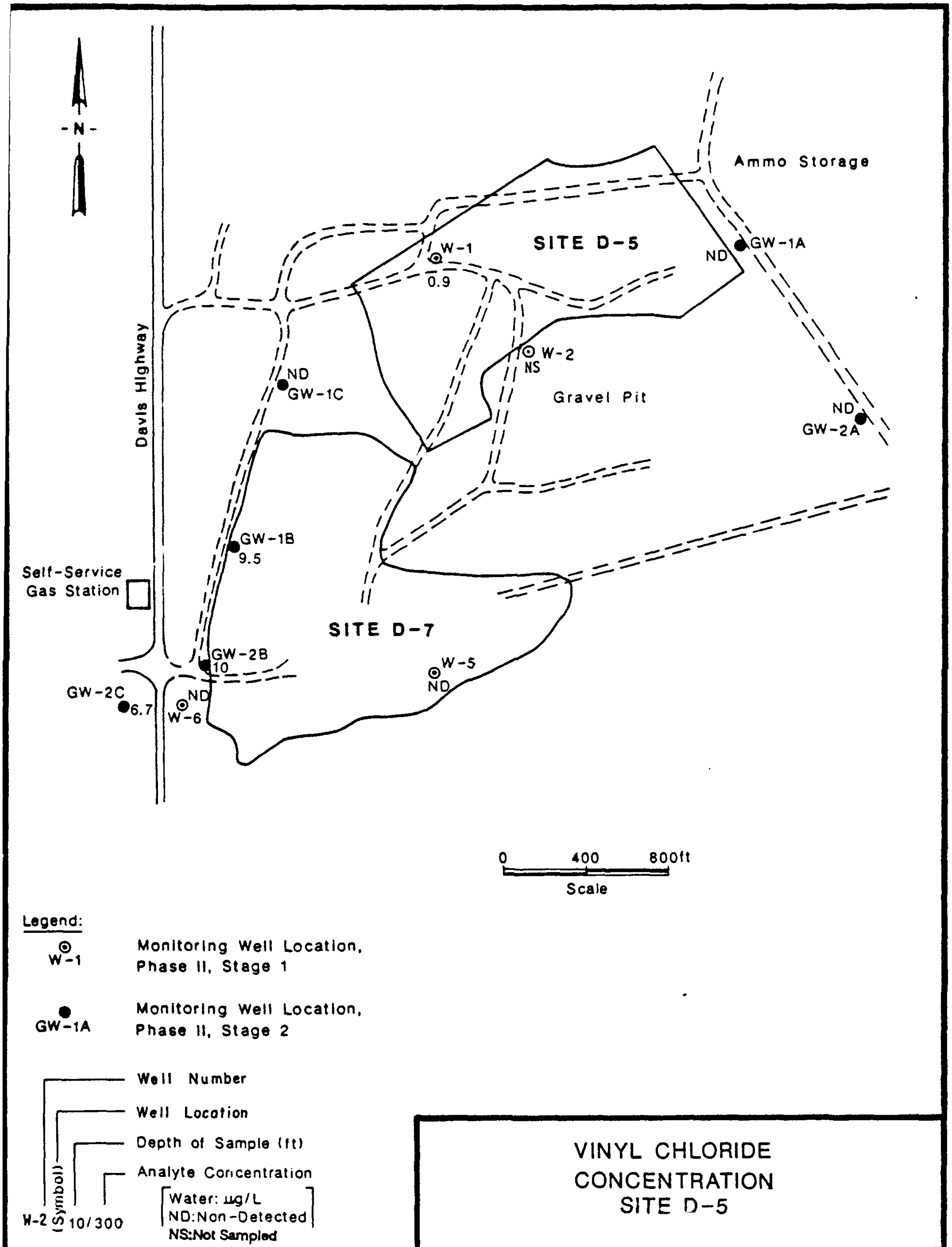
W-2 (Symbol) 10/300

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Water: µg/L
  - ND: Non-Detected
  - NS: Not Sampled

TRANS-1,2-DICHLOROETHENE
CONCENTRATION
SITE D-5

IRP Stage 3 RI/FS
Elmendorf AFB, AK

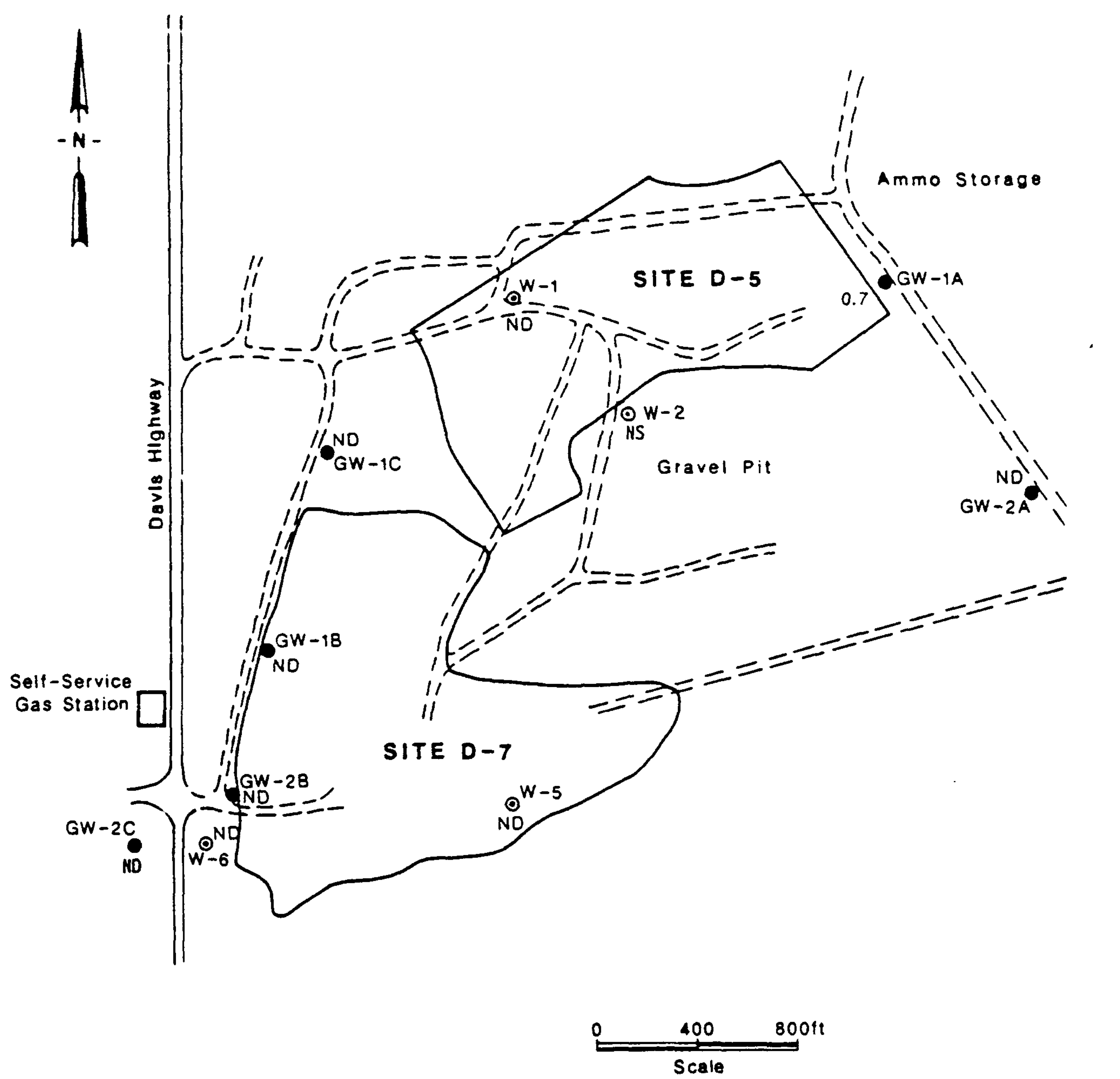
Figure
4.2.2.5



VINYL CHLORIDE
CONCENTRATION
SITE D-5

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.2.6



Legend:

- ◉ W-1 — Monitoring Well Location, Phase II, Stage 1
- ● GW-1A — Monitoring Well Location, Phase II, Stage 2

W-2 (Symbol) 10/300

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration [Water: mg/L, ND: Non-Detected, NS: Not Sampled]

TOTAL PETROLEUM HYDROCARBON
CONCENTRATION
SITE D-5

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.2.7

4.2.2.1.4 Analytical Results Table

Laboratory analytical results for Site D-5 are presented on Table 4.2.2.3.

Table 4.2.2.1 Field Parameters Site D-5

Well No.	Date Sampled	Temperature (^{o}C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
W-1	8/09/88	5.8	190	6.85	98	No odor or sheen
GW-1A	8/29/88	5.0	88	4.65	46	No odor or sheen
GW-1C	8/09/88	6.5	129	6.82	64	No odor or sheen
GW-2A	8/29/88	5.0	70	4.22	47	No odor or sheen

Table 4.2.2.2 Requested Analyses for Laboratory Samples at Site D-5

WATER

Test Number	Analysis
300	Common Anions
418.1	Petroleum Hydrocarbons
200.7	ICP Screen (total and dissolved)
206.2	Arsenic (total and dissolved)
239.2	Lead (total and dissolved)
245.1	Mercury (total dissolved)
270.2	Selenium (total and dissolved)
601	Purgeable Halocarbons
602	Purgeable Aromatics
625	Extractable Priority Pollutants

Table 4.2.2.3

Analytical Results - Site D-5

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	GW-2A 0687-NG-09GW-88-01 001434-0004	GW-1A 0687-NG-07GW-88-01 001434-0001	GW-1A GW-1A/75	GW-1A GW-1A/74	W-1 0687-NG-005 GW-88-0001 001240-0006	W-1 RESAMPLE 0687-NG-005-GW-880001R 001268-0001	W-1 GN840271
1,1,1-TRICHLOROETHANE	601	ug/L	200							
1,1-DICHLOROETHANE	601	ug/L								
Chloride	300.0	mg/L	250							
Dissolved Aluminum	200.7	mg/L							0.06	
Dissolved Arsenic	206.2	mg/L	0.05						0.004	
Dissolved Barium	200.7	mg/L	1.0	0.058	0.072				0.019	
Dissolved Calcium	200.7	mg/L		19.	22.				33.	
Dissolved Chromium	200.7	mg/L	0.05							
Dissolved Cobalt	200.7	mg/L								
Dissolved Copper	200.7	mg/L	1.0							
Dissolved Iron	200.7	mg/L	0.3						7.1	
Dissolved Lead	239.2	mg/L	0.05							
Dissolved Magnesium	200.7	mg/L		3.1	3.9				7.8	
Dissolved Manganese	200.7	mg/L	0.05						3.0	
Dissolved Nickel	200.7	mg/L								
Dissolved Sodium	200.7	mg/L	250	8.9	8.3				5.4	
Dissolved Vanadium	200.7	mg/L								
Dissolved Zinc	200.7	mg/L	5.0							
METHYLENE CHLORIDE	601	ug/L								
MOISTURE	GRAV.	%								
OIL & GREASE	413.2	mg/L								4
Recoverable Aluminum	200.7	mg/L		199.	93.			0.09		
Recoverable Arsenic	206.2	mg/L	0.05		0.014			0.007		
Recoverable Barium	200.7	mg/L	1.0	1.7	0.78			0.018		
Recoverable Beryllium	200.7	mg/L	0.0000039	0.005	0.003					
Recoverable Calcium	200.7	mg/L		94.	66.			26.		
Recoverable Chromium	200.7	mg/L	0.05	0.40	0.20					
Recoverable Cobalt	200.7	mg/L		0.41	0.25					
Recoverable Copper	200.7	mg/L	1.0	1.2	0.65			0.009		
Recoverable Iron	200.7	mg/L	0.3	400.	220.			8.3		
Recoverable Lead	239.2	mg/L	0.05	0.16	0.068					
Recoverable Magnesium	200.7	mg/L		112.	62.			7.1		
Recoverable Manganese	200.7	mg/L	0.05	26.	13.			2.6		
Recoverable Molybdenum	200.7	mg/L		0.10	0.06					
Recoverable Nickel	200.7	mg/L		0.91	0.45					
Recoverable Potassium	200.7	mg/L		7.	5.					
Recoverable Sodium	200.7	mg/L	250	6.2	5.8			4.7		
Recoverable Vanadium	200.7	mg/L		0.60	0.32					
Recoverable Zinc	200.7	mg/L	5.0	0.96	0.47					
Sulfate	300.0	mg/L	250					11.		
TDS	160.1	mg/L	500				180			170
TOC	415.1	mg/L								2
TOX	9020	ug/L								53
TRICHLOROETHENE (TCE)	601	ug/L	5.0							
TRICHLOROFLUOROMETHANE	601	ug/L								
Tetrachloroethene	EPA 601	ug/L	5.0							
Total Mercury	245.1	mg/L	0.002	0.004	0.0016			0.0003		
Total Petroleum Hydrocarbons	EPA 418.1	mg/L			0.7	1				
Vinyl chloride	EPA 601	ug/L	2.0					0.90		
bis(2-Ethylhexyl)phthalate	Method 625	ug/L		24.				23.		
trans-1,2-Dichloroethene	EPA 601	ug/L	70.0					3.2		

Table 4.2.2.3

Analytical Results - Site D-5

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-1 W-1-9	W-1 W-1/16	W-1 W-1/78	W-1 W-1/79	GW-1C 0687-NG-008 GW-88-0001 001240-0005	GW-1C RESAMPLE 0687-NG-008-GW-880001R 001268-0002	GW-1C GW-1C/14
1,1,1-TRICHLOROETHANE	601	ug/L	200							
1,1-DICHLOROETHANE	601	ug/L								
Chloride	300.0	mg/L	250							
Dissolved Aluminum	200.7	mg/L								
Dissolved Arsenic	206.2	mg/L	0.05							
Dissolved Barium	200.7	mg/L	1.0						0.008	
Dissolved Calcium	200.7	mg/L							27.	
Dissolved Chromium	200.7	mg/L	0.05							
Dissolved Cobalt	200.7	mg/L								
Dissolved Copper	200.7	mg/L	1.0							
Dissolved Iron	200.7	mg/L	0.3						0.05	
Dissolved Lead	239.2	mg/L	0.05							
Dissolved Magnesium	200.7	mg/L							4.8	
Dissolved Manganese	200.7	mg/L	0.05						0.095	
Dissolved Nickel	200.7	mg/L								
Dissolved Sodium	200.7	mg/L	250						3.0	
Dissolved Vanadium	200.7	mg/L								
Dissolved Zinc	200.7	mg/L	5.0							
METHYLENE CHLORIDE	601	ug/L								0.72
MOISTURE	GRAV.	.		10						
OIL & GREASE	413.2	mg/L								
Recoverable Aluminum	200.7	mg/L						8.1		
Recoverable Arsenic	206.2	mg/L	0.05					0.004		
Recoverable Barium	200.7	mg/L	1.0					0.080		
Recoverable Beryllium	200.7	mg/L	0.0000039							
Recoverable Calcium	200.7	mg/L						26.		
Recoverable Chromium	200.7	mg/L	0.05					0.01		
Recoverable Cobalt	200.7	mg/L						0.02		
Recoverable Copper	200.7	mg/L	1.0					0.051		
Recoverable Iron	200.7	mg/L	0.3					14.		
Recoverable Lead	239.2	mg/L	0.05					0.013		
Recoverable Magnesium	200.7	mg/L						8.4		
Recoverable Manganese	200.7	mg/L	0.05					0.85		
Recoverable Molybdenum	200.7	mg/L								
Recoverable Nickel	200.7	mg/L						0.03		
Recoverable Potassium	200.7	mg/L								
Recoverable Sodium	200.7	mg/L	250					3.1		
Recoverable Vanadium	200.7	mg/L						0.02		
Recoverable Zinc	200.7	mg/L	5.0					0.04		
Sulfate	300.0	mg/L	250					18.		
TDS	160.1	mg/L	500			130				
TOC	415.1	mg/L								
TOX	9020	ug/L								
TRICHLOROETHENE (TCE)	601	ug/L	5.0							
TRICHLOROFLUOROMETHANE	601	ug/L								0.51
Tetrachloroethene	EPA 601	ug/L	5.0					0.42		0.58
Total Mercury	245.1	mg/L	0.002					0.0010		
Total Petroleum Hydrocarbons	EPA 418.1	mg/L					0.2			
Vinyl chloride	EPA 601	ug/L	2.0							
bis(2-Ethylhexyl)phthalate	Method 625	ug/L						13.		
trans-1,2-Dichloroethene	EPA 601	ug/L	70.0		3.2					1.1

Table 4.2.2.3

Analytical Results - Site D-5

Parameter	Method	Units	Standards, Criteria and Action Levels	GW-1C	W-2	W-2	W-2	GW-1B	GW-1B	GW-1B
			Federal/State	GW-1C/76	W-2-9	W-2/17	GN840272	GW-1B/15	GW-1B/67	GW-1B/72
1,1,1-TRICHLOROETHANE	601	ug/L	200					32		
1,1-DICHLOROETHANE	601	ug/L						4.7		
Chloride	300.0	mg/L	250							
Dissolved Aluminum	200.7	mg/L								
Dissolved Arsenic	206.2	mg/L	0.05							
Dissolved Barium	200.7	mg/L	1.0							
Dissolved Calcium	200.7	mg/L								
Dissolved Chromium	200.7	mg/L	0.05							
Dissolved Cobalt	200.7	mg/L								
Dissolved Copper	200.7	mg/L	1.0							
Dissolved Iron	200.7	mg/L	0.3							
Dissolved Lead	239.2	mg/L	0.05							
Dissolved Magnesium	200.7	mg/L								
Dissolved Manganese	200.7	mg/L	0.05							
Dissolved Nickel	200.7	mg/L								
Dissolved Sodium	200.7	mg/L	250							
Dissolved Vanadium	200.7	mg/L								
Dissolved Zinc	200.7	mg/L	5.0							
METHYLENE CHLORIDE	601	ug/L				0.57		2.6		
MOISTURE	GRAV.	%			13					
OIL & GREASE	413.2	mg/L			25		5			
Recoverable Aluminum	200.7	mg/L								
Recoverable Arsenic	206.2	mg/L	0.05							
Recoverable Barium	200.7	mg/L	1.0							
Recoverable Beryllium	200.7	mg/L	0.0000039							
Recoverable Calcium	200.7	mg/L								
Recoverable Chromium	200.7	mg/L	0.05							
Recoverable Cobalt	200.7	mg/L								
Recoverable Copper	200.7	mg/L	1.0							
Recoverable Iron	200.7	mg/L	0.3							
Recoverable Lead	239.2	mg/L	0.05							
Recoverable Magnesium	200.7	mg/L								
Recoverable Manganese	200.7	mg/L	0.05							
Recoverable Molybdenum	200.7	mg/L								
Recoverable Nickel	200.7	mg/L								
Recoverable Potassium	200.7	mg/L								
Recoverable Sodium	200.7	mg/L	250							
Recoverable Vanadium	200.7	mg/L								
Recoverable Zinc	200.7	mg/L	5.0							
Sulfate	300.0	mg/L	250							
TDS	160.1	mg/L	500	140		81	95		130	
TOC	415.1	mg/L								
TOX	9020	ug/L					34			
TRICHLOROETHENE (TCE)	601	ug/L	5.0					2.7		
TRICHLOROFLUOROMETHANE	601	ug/L						0.6		
Tetrachloroethene	EPA 601	ug/L	5.0			0.48		0.49		
Total Mercury	245.1	mg/L	0.002							
Total Petroleum Hydrocarbons	EPA 418.1	mg/L								0.5
Vinyl chloride	EPA 601	ug/L	2.0							
bis(2-Ethylhexyl)phthalate	Method 625	ug/L								
trans-1,2-Dichloroethene	EPA 601	ug/L	70.0			1.3				

4.2.2.1.5 Discussion of Analytical Data

Volatile organic compounds including tetrachloroethene, trans-1,2,-dichloroethene, vinyl chloride and bis(2-ethylhexyl) phthalate were detected in water samples obtained from existing groundwater monitoring wells at Site D-5 (Figures 4.1.2.4 through 4.1.2.7). However, the concentrations detected were generally low and isolated to 1 or 2 wells. QA/QC data indicate that bis (2-ethylhexyl) phthalate was a field or laboratory contaminant. Trans-1,2-dichloroethene and vinyl chloride were detected at concentrations of 3.2 and 0.9 ug/L in well W-1. A water sample from well GW-1C contained tetrachloroethene at a concentration of 0.42 ug/L, and total petroleum hydrocarbons were detected at a level of 0.7 mg/L in well GW-1A.

Total recoverable metals such as aluminum (0.13 to 199 mg/L), iron (8.3 to 400 mg/L), and manganese (0.85 to 112 mg/L) were detected in water samples. In all cases the higher concentrations of these metals were found in samples from wells GW-1A and GW-2A; these wells are located on the eastern perimeter of the landfill. Significantly lower concentrations were detected in samples from wells W-1 and GW-1C, located to the west. Dissolved concentrations ranged from arsenic at 0.004 mg/L to magnesium at 7.8 mg/L to iron at 27 mg/L.

Total calcium (26 to 94 mg/L), sodium (3.0 to 6.2 mg/L), and potassium (5 to 7 g/kg) were detected in water from Site D-5. Greater concentrations of calcium were detected in wells GW-1A and GW-2A, and potassium was detected in samples from only these 2 wells.

Sulfate and chloride ions were detected in water samples from all wells GW-1C and W-1 at concentrations ranging from 11 to 18 mg/L and 1.1 to 8.7 mg/L, respectively.

Concentration at less than 2 mg/L of total recoverable barium were detected in water samples from all wells. Total chromium, copper, cobalt, nickel, vanadium and zinc were detected at concentrations of 0.20, 0.65, 0.25, 0.45, 0.32 and 0.47 mg/L, respectively, in water samples from well GW-1A, and at concentrations of 0.40, 1.2, 0.41, 0.91, 0.60 and 0.96 mg/L, respectively, in a water sample from well number GW-2A. Water samples from the 2 wells to the east contained less of these total recoverable metals; for example, only copper was detected (0.009 mg/L) in well W-1. Water from well GW-1C contained all of these metals, but at concentrations of less than 0.05 mg/L.

Trace amounts of dissolved and total arsenic (0.004 to 0.014 mg/L) were detected in samples from wells W-1 and GW-1C to the east, and in well GW-1A to the west. Total lead (0.013 to 0.16 mg/L) and total mercury (0.0003 to 0.004 mg/L) were detected in all wells; the highest concentrations of these elements were detected in water from well GW-2A. Total recoverable beryllium was detected in water samples from wells GW-1A and GW-2A at concentrations of less than 0.006 mg/L, and water from well GW-2A also contained total molybdenum (0.10 mg/L).

4.2.2.2 Sampling or Analytical Problems

Sampling and analytical problems that may have been encountered at Site D-5 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the workplan.

4.2.2.2.1 Loss of Samples

No water samples collected for laboratory analyses were lost from Site D-5.

4.2.2.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is possible that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see

Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. However, bis(2-ethylhexyl) phthalate was detected in samples from wells W-1, GW-1C, and GW-2A at concentrations of 23, 13, and 24 mg/L, respectively. Based on the QA/QC data, bis(2-ethyehexyl) phthalate is considered to be a laboratory or field contaminant at Site D-5.

4.2.2.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Five previously installed wells were to be sampled at Site D-5. However, well W-2 had been destroyed by enlargement of the nearby gravel pit. Therefore, only 4 water samples were retrieved from Site D-5. In addition, water samples collected from 2 of the wells (W-1 and GW-1C) that were to be tested for dissolved metals were not originally filtered in the field. This was corrected by resampling the 2 wells for dissolved metals only, and filtering the samples onsite prior to shipment.

4.2.2.2.4 Corrective Actions Applied to Out-of-Control Events, Including a Chronology of Rerunning Samples and Controls

Two of the 4 wells at Site D-5 were resampled for dissolved metals. The following Table 4.2.2.4. shows when sampling and resampling activities were conducted.

Table 4.2.2.4 Resampling Dates - Dissolved Metals Analysis

Well Number	Original Sampling Date	Resampling Date*
W-1	8/9/88	8/15/88
GW-1A	8/29/88	NA
GW-1C	8/9/88	8/15/88
GW-2A	8/29/88	NA

* NA - Not Applicable

4.2.2.3 Significance of Findings at D-5

Analytical results for water samples from Site D-5 showed contamination by various organic compounds and metals. Concentrations of barium, beryllium, chromium, copper, iron, lead, manganese, and mercury exceed the groundwater cleanup levels as described in Section 4.1. Total recoverable metals values were generally slightly higher than the corresponding dissolved values. Considering that these wells are from previous site investigations and are more thoroughly developed, the total recoverable values can be considered representative of groundwater quality. There is some evidence that soils in the groundwater are the cause of the high metals in groundwater cannot unilaterally be disregarded as soil phenomena at this point.

Contamination by several halocarbon compounds detected in all 4 of the wells at Site D-5 during Phase II, Stage 2 analyses (Dames and Moore, 1987) was not confirmed by the samples analyzed by this study.

The source of metals in the groundwater is likely steel and metal alloy debris buried in the landfill. Basic receptors are humans, wildlife, and plants. Pathways of exposure to the receptors of these metals include ingestion of groundwater by humans and wildlife and uptake by plants.

4.2.2.3.1 Zones of Contamination

The data density of the site allows for little generalization of the zones of contamination. The only primary organic contaminants detected at the site was vinyl chloride. This compound was detected in well W-1 at a concentration below the State of Alaska standard of 2.0 ug/L. The concentrations of certain metals in groundwater from wells GW-1A and GW-2A including barium, beryllium, chromium, copper

and lead, were above groundwater cleanup levels as described in Section 4.1. They were also much higher than the concentrations detected in groundwater from Wells W-1 and GW-1C.

4.2.2.3.2 Contaminant Migration

The primary migration medium at Site D-5 is groundwater. The data presented in this study do not provide clear evidence that contaminants are migrating in the groundwater. A geophysical survey done for Site D-13 (see Section 4.2.4) suggests that the 2 upgradient wells, GW-1A and GW-2A, are outside of the landfill boundary, and wells W-1 and GW-1C are within the boundary. Contamination by vinyl chloride was only detected in well W-1, a well suspected of being within the landfill boundary.

4.1.2.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite migration and off-Base is unknown at this time. There are no offsite downgradient wells in the immediate vicinity to make an accurate assessment of this. The wells containing the highest metals concentrations are located outside of the assumed landfill boundary, but in an area expected to be seasonally upgradient relative to general groundwater flow.

4.2.2.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The horizontal hydraulic conductivity was estimated to be 300 feet per day. This value provides a conservative estimate in terms of

risk assessment. The rate of migration of the contaminants in the groundwater will depend upon the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. These factors which impact migration will act, in most cases to inhibit contaminant migration. This study developed insufficient data to make an accurate estimate of migration rate of these dissolved metals.

4.2.2.3.2.3 Time of Travel to Receptors

Primary receptors are humans, plants, and wildlife. Even though offsite migration of contaminants could not be verified due to lack of downgradient information, the primary pathway is through contaminated groundwater. Base well 42 is located downgradient about 5200 feet from Site D-5 at Building 11-200. Hydraulic conductivities have not been estimated for this site; thus time of travel to this well cannot be determined. However, base well 42 is an artesian well, drilled to a depth of 225 feet (Phase II, Stage 2 Report, Dames and Moore, 1987). The water from base well 42 is contained inside a casing as it flows through the zone of potential contamination detected at Site D-5, and is unlikely to be affected by impacts from the site. A gravel pit adjacent to the site has the potential to expose groundwater during gravel removal operations.

4.2.2.3.2.4 Expected Spatial and Temporal Variations in Concentration

Groundwater flow is primarily to the west-northwest at Site D-5. The spacial extent of contamination past the site boundaries is unknown since no downgradient wells exist that are clearly offsite. The

contamination may or may not extend offsite. Inorganic contamination previously detected in water from base well 42 may or may not have its source at Site D-5.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of the metals is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.2.3.3 Baseline Risk Assessment

The presence of contamination with respect to exposure pathways, presence of receptors, and health effects is discussed in the following sections.

4.2.2.3.3.1 Waste Characterization

Tetrachloroethene, trans-1,2-dichloroethene and vinyl chloride were detected in groundwater samples at Site D-5. Vinyl chloride is used in plastics and as a refrigerant and is listed as a human carcinogen by the EPA. Tetrachloroethene and trichloroethane are used as solvents and degreasers and are listed as EPA animal carcinogens. Quite possibly, trans-1,2-dichloroethene is present as a decay product of trichloroethene (TCE) or tetrachloroethene.

Sources of dissolved metals in the groundwater at Site D-5 may be from landfill debris or naturally found in soils. These metals are used in steel and metal alloys and can affect the central nervous system in humans. However, toxicity from iron and manganese which exceeded the secondary standards in both the total recoverable and dissolved metals analyses, requires concentrations much higher than the secondary

maximum contaminant levels of 0.3 and 0.05 mg/L, respectively (18 AAC 80.060).

4.2.2.3.3.2 Source and Release Characterization

Materials buried in the landfill are a potential source of metallic and organic contamination. Records were not kept of materials (and quantities) buried in the landfill; thus, estimating volumes of contaminants is difficult.

4.2.2.3.3.3 Fate and Transport of Contaminants

The fate of metals released to the environment at Site D-5 includes oxidation, biological uptake, and/or chelation by water organics or cations such as Cl- or OH-. Transport of metals may have occurred by leaching into the water from debris buried at Site D-5. These anions may then have become adsorbed onto soil particles, remaining bound until conditions (pH and temperature) allow the anions to dissolve into interstitial water which eventually percolates to the saturation zone. At the water table, nonsoluble contaminants are able to migrate along the groundwater table gradient. Dissolved contaminants can flow with the groundwater through the process of advection.

The fate of the organic compounds at the site include long-term natural degradation, dispersion into the soil column dispersion into infiltrating water, and uptake by living organisms. Transport of the organic contaminants will occur primarily through groundwater movement (advection and percolation) and by entrainment in water flowing along impermeable boundaries or along the water table.

Evidence of the metal anion migration and/or dispersion is not readily apparent at the site. If dissolved metal contaminants were migrating from the site, one would expect higher concentrations in the down-

gradient wells to the west. The actual transport rate, plume dimensions and precise direction of contaminant migration are not known for this site.

The drinking water well at building number 11-200 (base well 42) was last tested for volatile organics and metals in 1987. No volatile organics were detected in the sample, and all metals were detected at levels less than State of Alaska primary standards.

4.2.2.3.3.4 Exposure Pathways

The primary pathways of exposure are ingestion of or contact with contaminated groundwater, plants or wildlife.

4.2.2.3.3.5 Identification of Receptors

Human receptors include anyone drinking from the active well in the area, i.e. base well 42, should it become contaminated.

Wildlife may be exposed through the ingestion of contaminated water that may be exposed during gravel extraction operations adjacent to the site.

4.2.2.3.3.6 Threat to Human Health

The most significant potential threat to human health is the drinking of water from base well 42, should that well become contaminated via this source.

4.2.2.3.3.7 Carcinogenetic Risks

Vinyl chloride, a know carcinogen, was detected in well W-1 at a concentration of 0.90 mg/L. This is below the MCL of 2 mg/L.

4.2.2.3.3.8 Threat to Wildlife

Wildlife may be exposed to contaminated groundwater if the water is exposed by gravel pit operations adjacent to Site D-5. However, the quantity of groundwater exposed by the removal of gravel has not been determined and is expected to change seasonally. It is also not known if any exposed water would be contaminated by sources identified at Site D-5. Contaminated groundwater may be exposed if flow conditions change, or if the gravel pit should extend into areas of the site. It is not known if any exposed water would be contaminated by sources identified at Site D-13. The threat to wildlife from contamination at the site is assessed as low.

4.2.2.4 Prioritization of Sites for Remedial Alternatives

Contamination in groundwater samples from Site D-5 were above groundwater cleanup levels as discussed in Section 4.1. In addition, Site D-5 is close to several other sites (Sites D-13, D-7, and NS-2) where contamination was detected in the groundwater. It is recommended that Sites D-5, D-7, D-13, and NS-2 be combined due to their proximity and the similarity of the contaminants found at these sites. This new site would be assigned a high-priority for remedial alternatives due to contaminant levels exceeding State of Alaska water quality regulations and the evidence of offsite migration.

In addition, expansion of the gravel pit to the north should be halted. Five monitoring wells have already been destroyed: W-2, D13-02, D13-03, GW-1B, and GW-1C. If further expansion in the direction of Site D-5 continues, contaminated groundwater may be exposed. Recommendations for further investigation at the combined site are described under Results for Site NS-2, DRMO Scrap Pile, in Section 4.2.21.4.

4.2.3 Discussion of Results for Site D-7, Sanitary Landfill

Site D-7 (Figure 4.2.3.1) occupies about 35 acres and has been used since 1965 for the disposal of base-generated refuse, scrap metal, construction rubble, drums of asphalt, and empty pesticide containers (Engineering-Science, 1983). In the past, small quantities of shop wastes were disposed at this site. A section in the active area of the landfill is used for the disposal of asbestos waste generated on Elmendorf AFB.

4.2.3.1 Presentation of Results from Site D-7

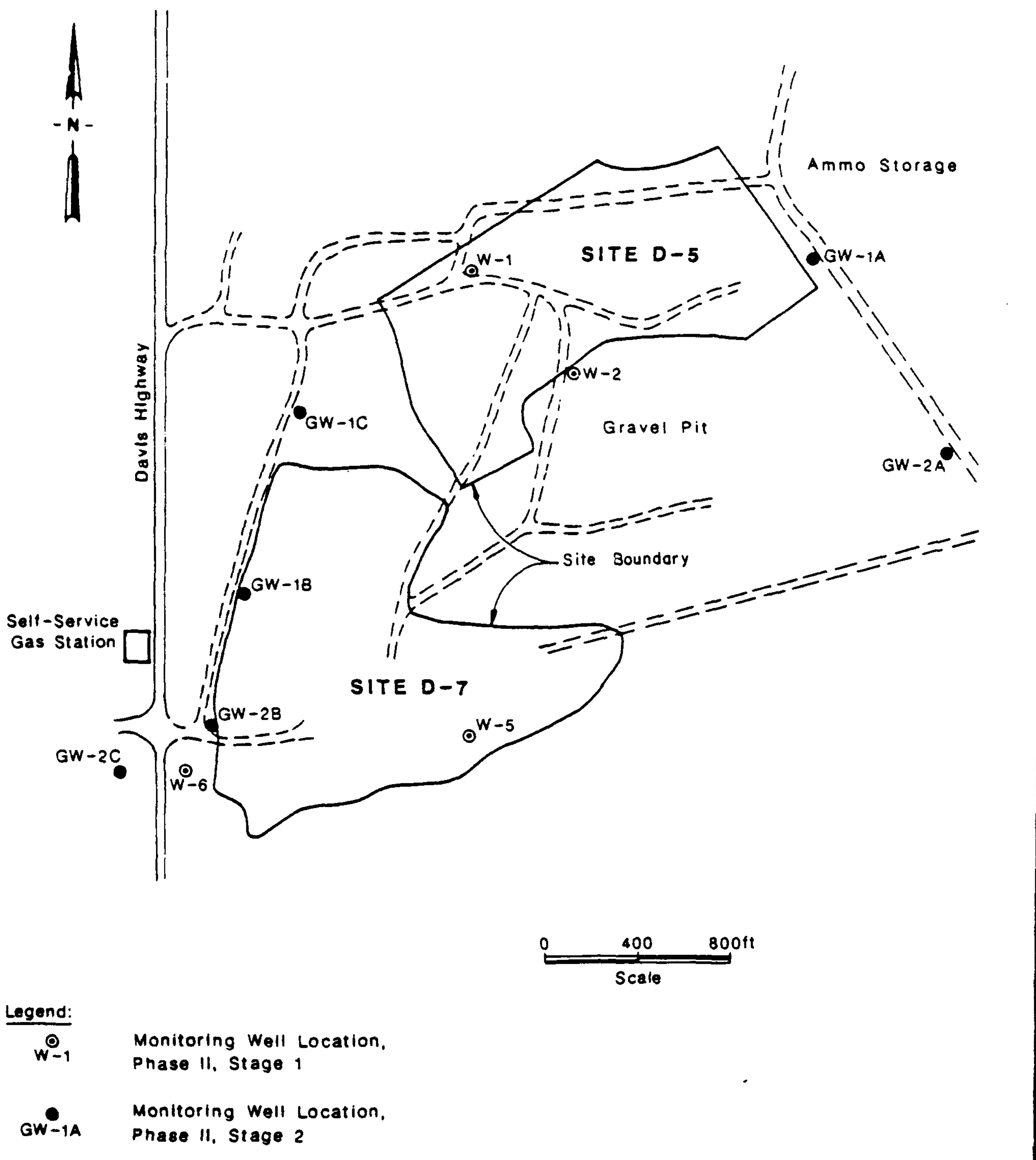
Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on site maps.

4.2.3.1.1 Site Geology

Site D-7 is a sanitary landfill located at an elevation of about 210 feet on late-Quaternary glacial outwash sand and gravel deposits. The site surface has been modified by landfilling and gravel extraction activities and has some visible debris. Grass, alder and willow comprise most of the vegetation. A schematic geologic cross section is provided in Figure 4.2.3.2 which shows the site is underlain by sandy gravel and gravelly sand with some silty layers.

4.2.3.1.2 Site Hydrogeology

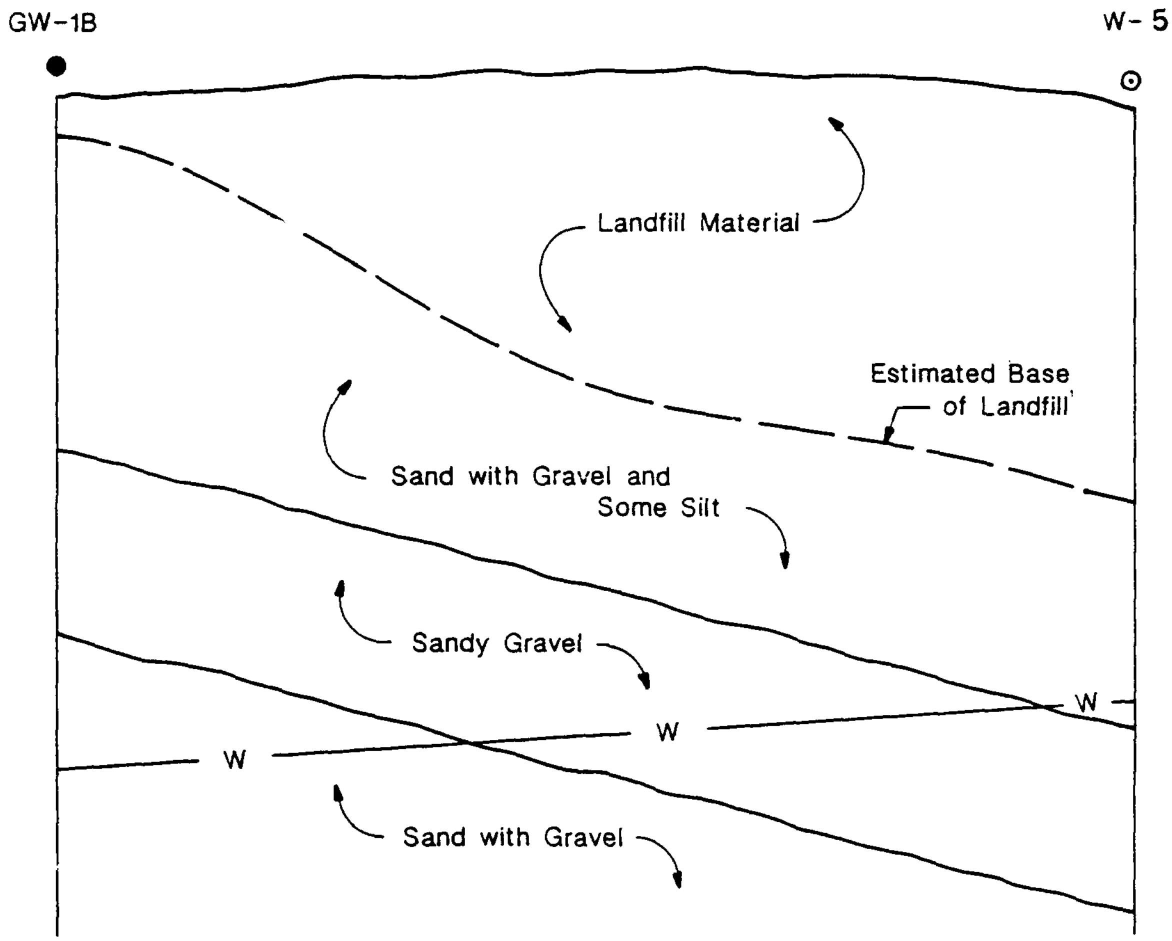
Site D-7 is underlain by sands and gravels with a water table depth of approximately 30 feet. The direction of groundwater flow is based on comparison of regional groundwater trends with water level measurements at 13 wells in the area. The flow direction is west-northwest with a gradient of approximately 20 feet per mile (Figure



LOCATION MAP
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.3.1



Legend:

W-5 — Monitoring Well Location, Phase II, Stage 1.

GW-1B — Monitoring Well Location, Phase II, Stage 2.

—— W —— Projected Water Table

0 100 200ft
VERTICAL SCALE

0 200 400ft
HORIZONTAL SCALE

Note:

1. Based on geophysical and test boring logs.
2. Cross section location shown on Figure 4.2.3.2
3. Horizontal scale: 1 inch = 200 feet.
4. Vertical scale: 1 inch = 100 feet.

GEOLOGIC CROSS SECTION
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.3.2

4.2.3.3). The site is located less than 0.5 miles downgradient from Ship Creek, which loses water to the groundwater system in this area. Geologic deposits at the sites are similar to deposits at the pump test site (see Section 4.2.26). Hydraulic conductivity values have not yet been estimated for this site.

4.2.3.1.3 Analytical Results

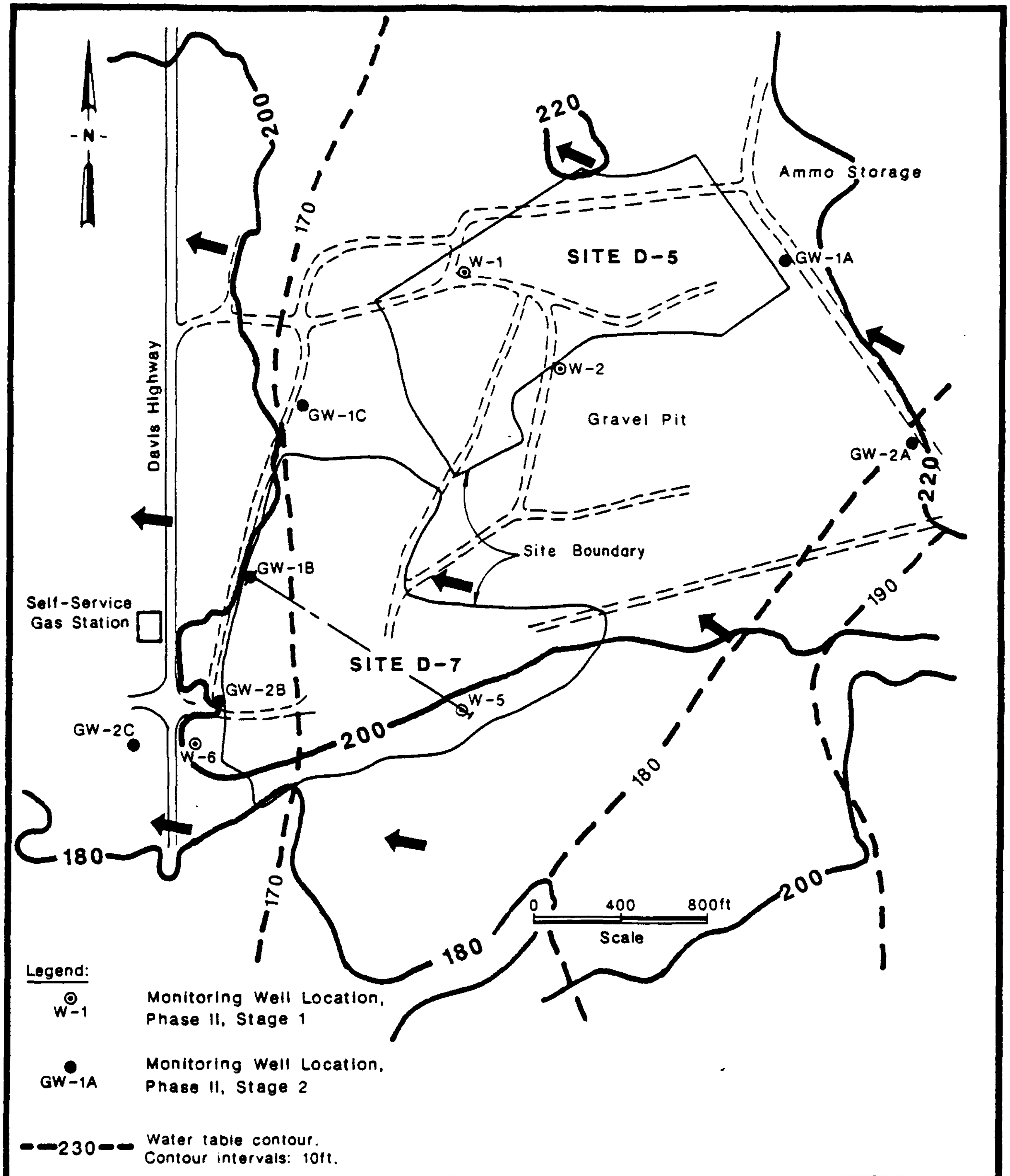
Field analytical results, observations, and laboratory analytical results are discussed in the following section.

4.2.3.1.3.1 Field Analytical Results and Observations

Field activities at Site D-7 primarily involved evaluation and testing at the existing monitoring wells. Field parameters measured at Site D-7 during groundwater sampling are presented on Table 4.2.3.1.

4.2.3.1.3.2 Laboratory Analytical Results

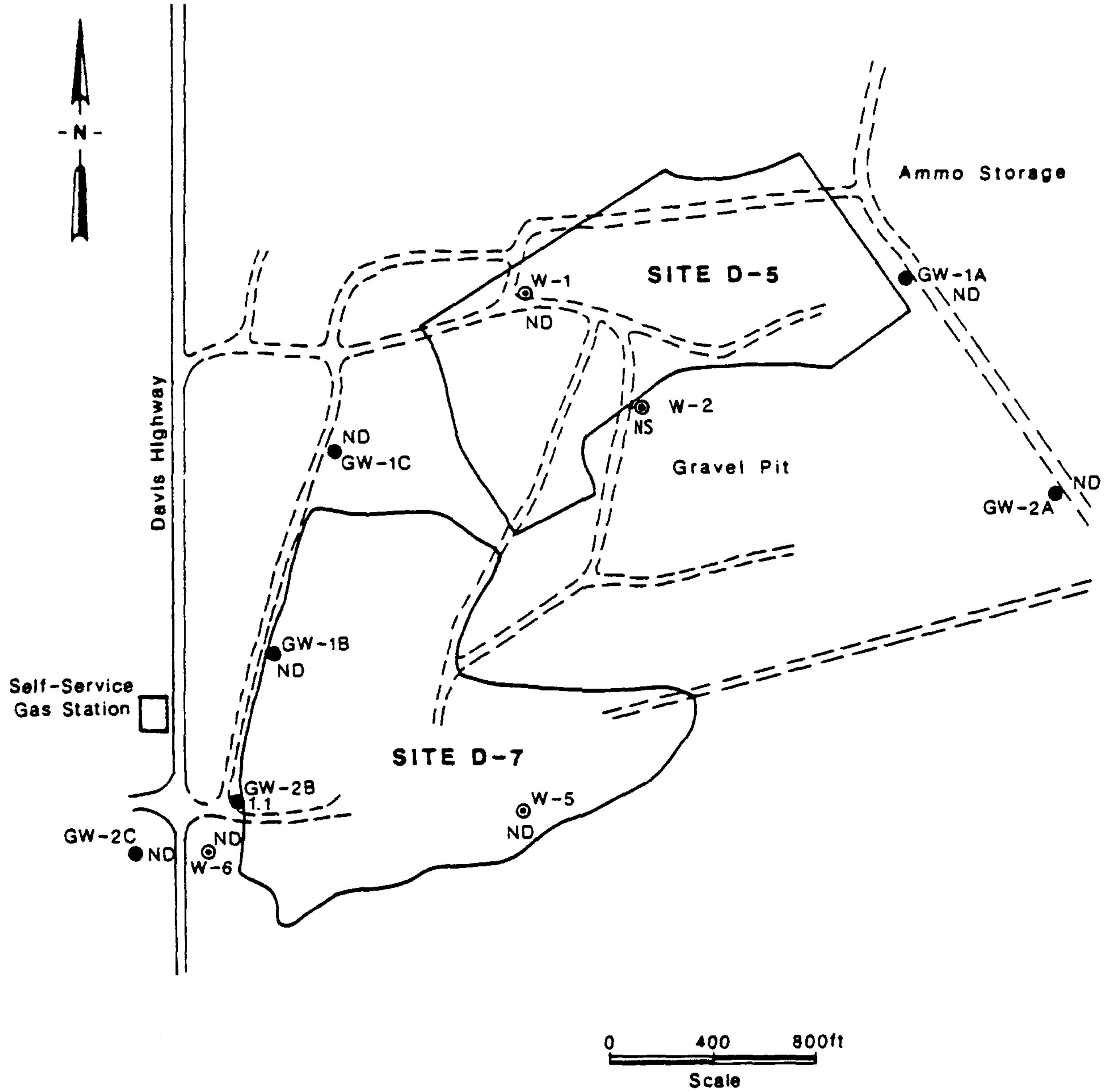
The laboratory analytical program for Site D-7 is presented on Table 4.2.3.2, and the sample plan for the base-wide field investigation program is included in Appendix B. Major organic contaminants identified from the laboratory analysis of samples collected at Site D-7 are plotted on Figures 4.2.3.4 through 4.2.3.14. A separate map of each identified organic contaminant is provided; the analyte concentrations detected in the water samples are plotted next to the corresponding well. Results of tests for metals and other contaminants are presented in Table 4.2.3.3.



HYDROGEOLOGIC MAP
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.3.3



Legend:

W-1 — Monitoring Well Location, Phase II, Stage 1

GW-1A — Monitoring Well Location, Phase II, Stage 2

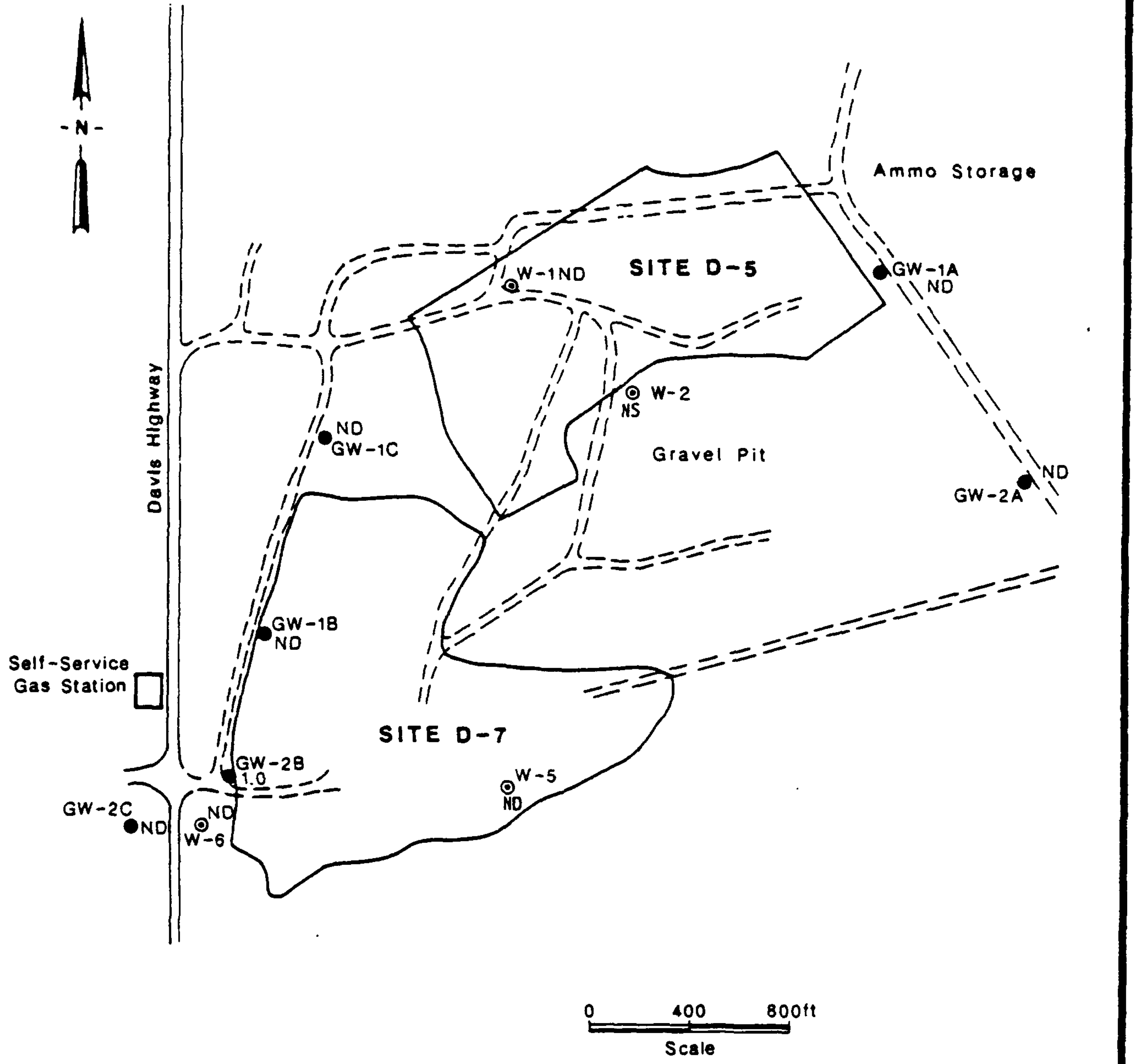
W-2 (Symbol) 10/300

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Water: µg/L
  - ND: Non-Detected
  - NS: Not Sampled

BENZENE
CONCENTRATION
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.3.4



Legend:

W-1 — Monitoring Well Location, Phase II, Stage 1

GW-1A — Monitoring Well Location, Phase II, Stage 2

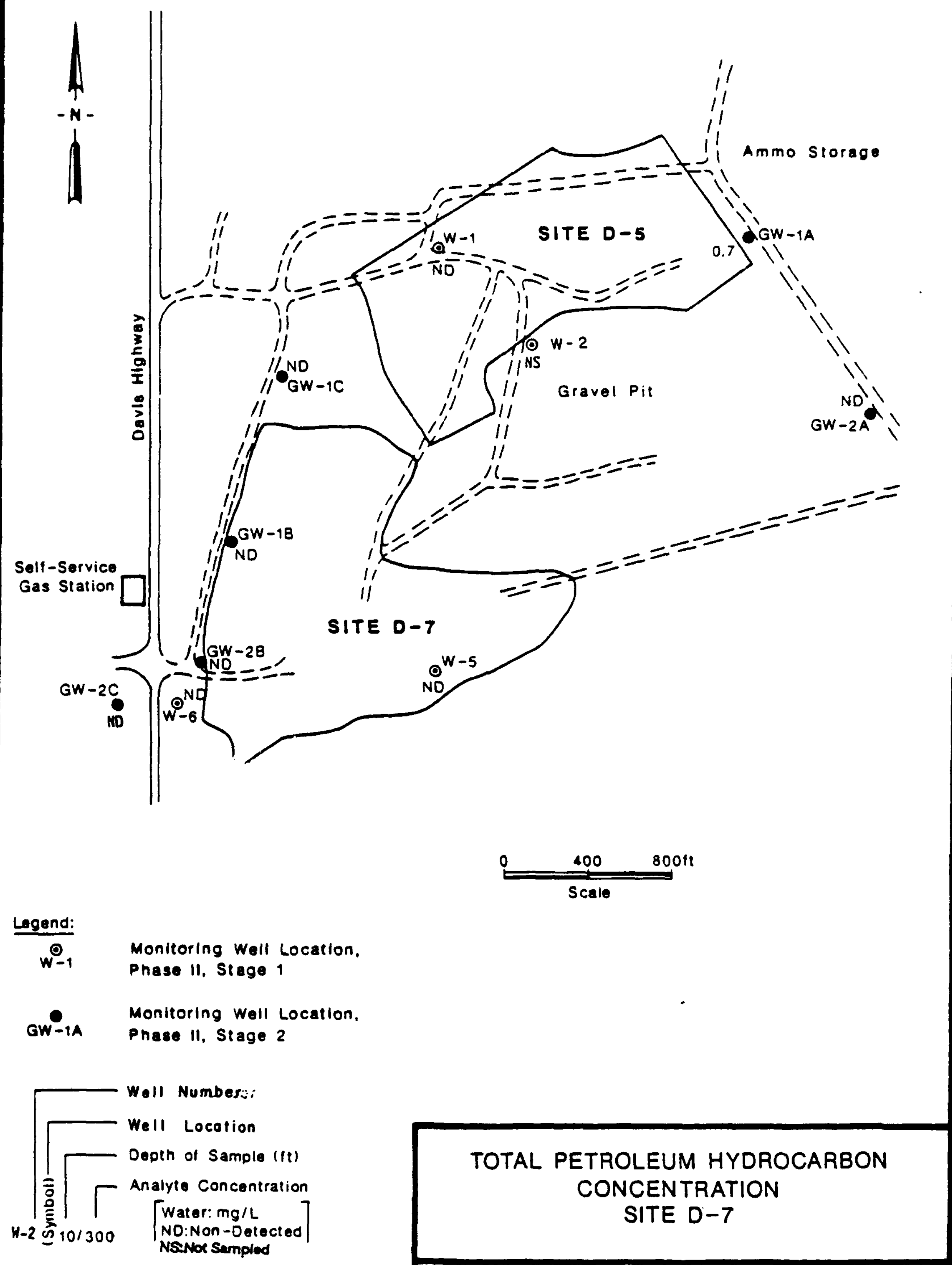
W-2 (Symbol) 10/300

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Water: µg/L
  - ND: Non-Detected
  - NS: Not Sampled

TOLUENE
CONCENTRATION
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

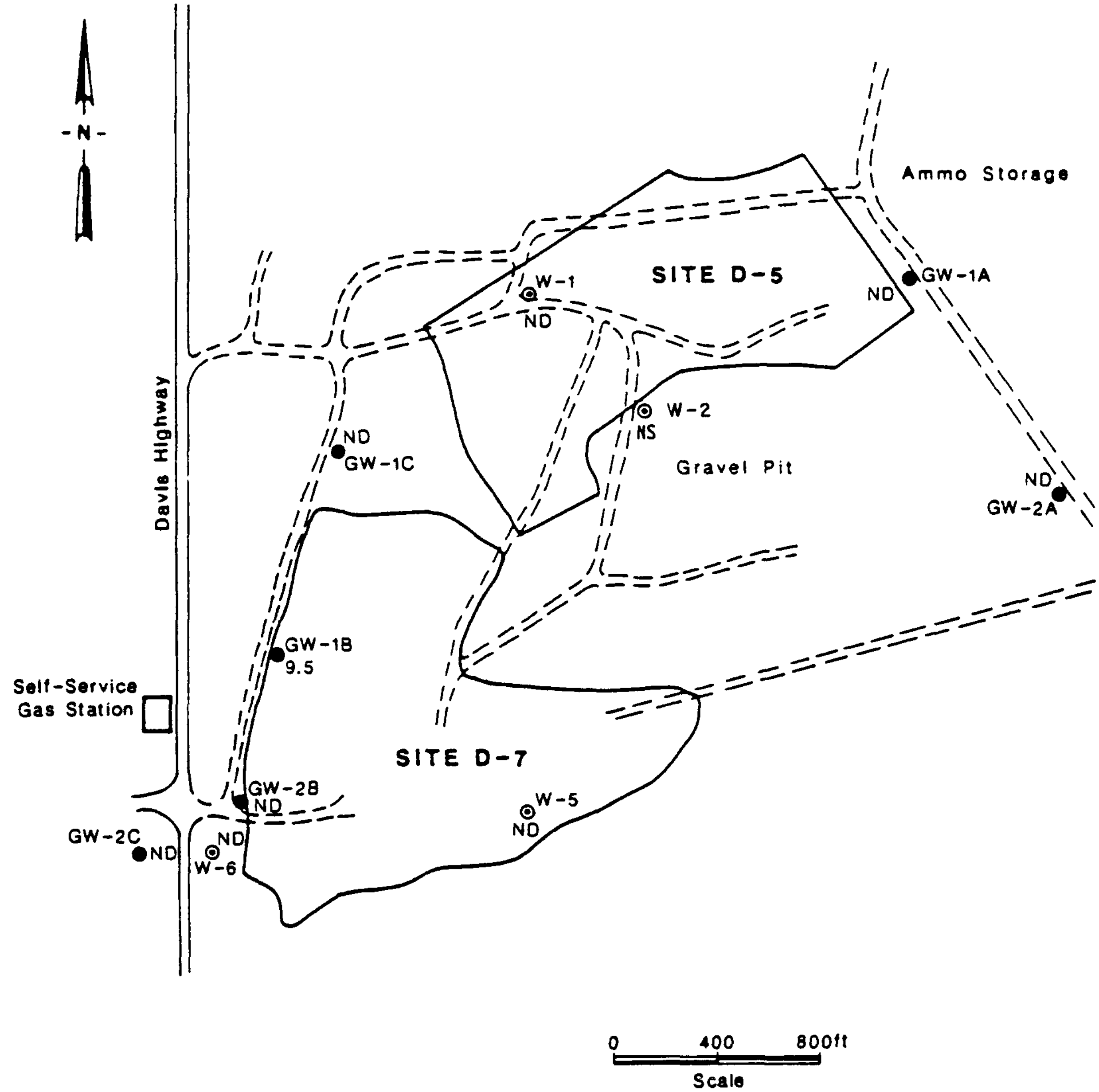
Figure
4.2.3.5

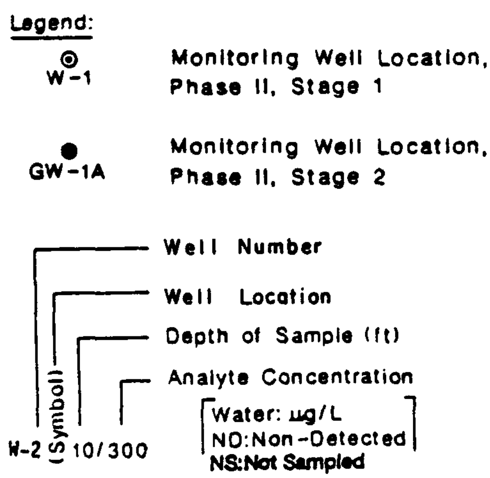


TOTAL PETROLEUM HYDROCARBON CONCENTRATION SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.3.6

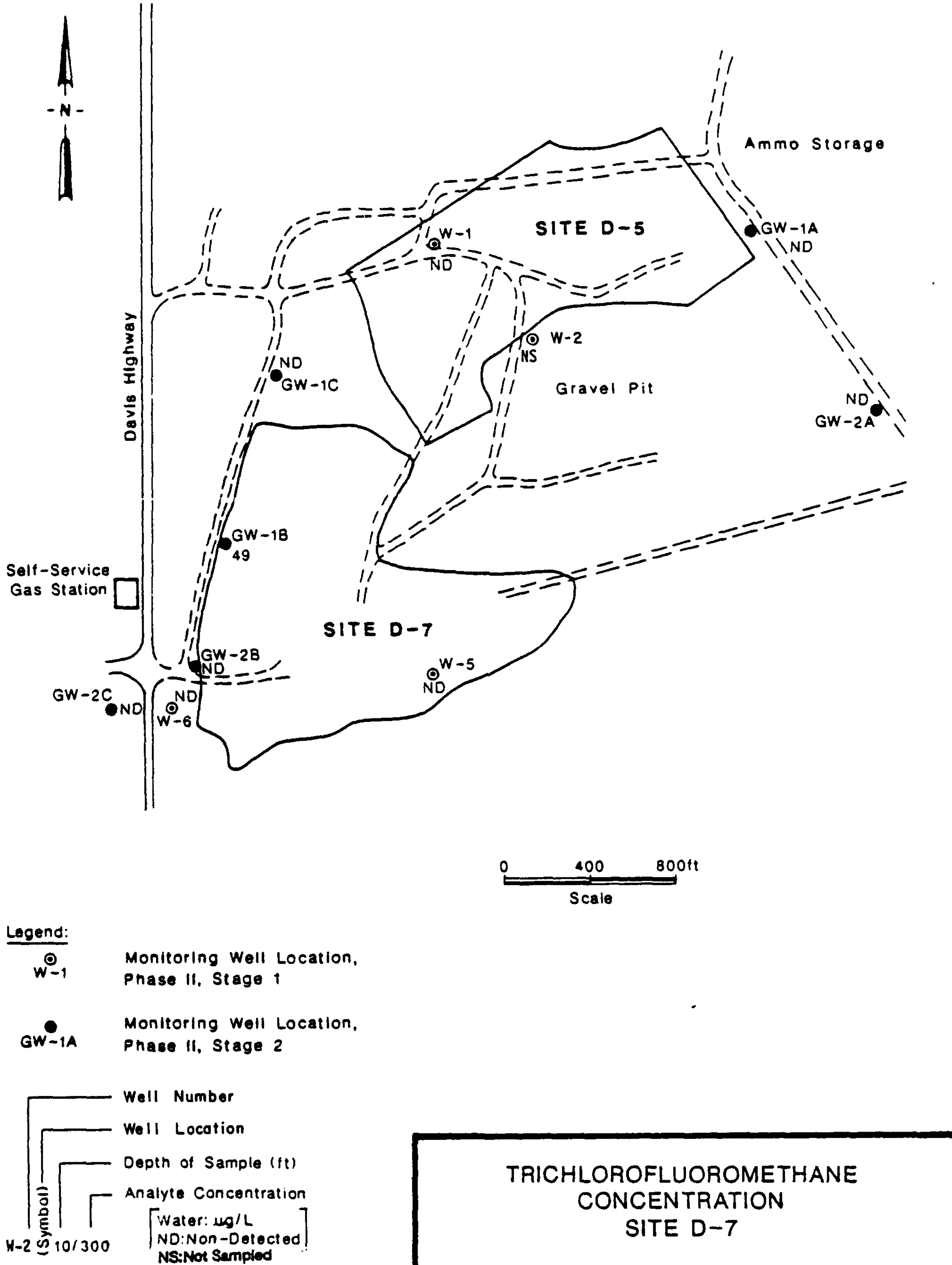




CHLOROETHANE
CONCENTRATION
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

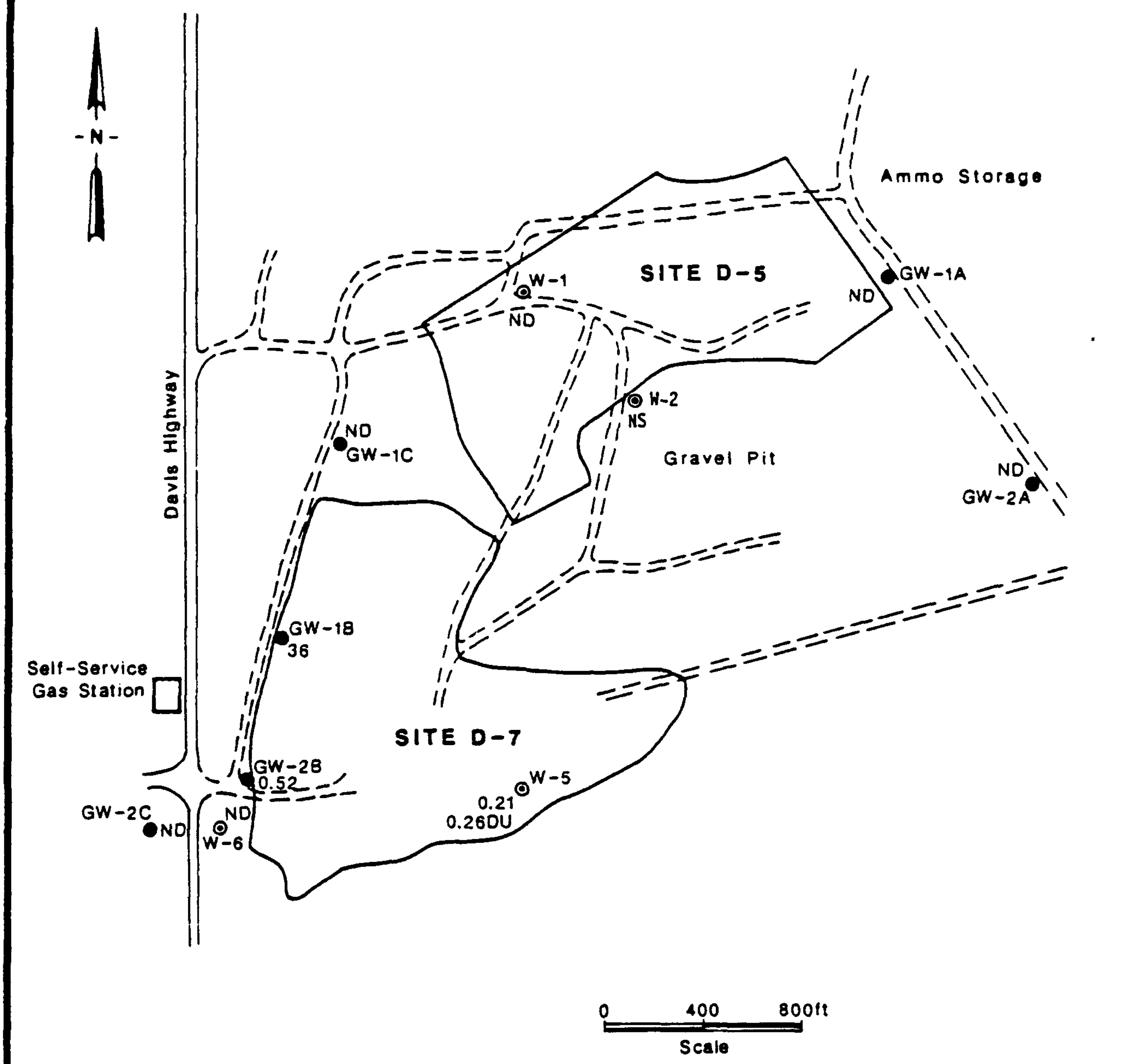
Figure
4.2.3.7



TRICHLOROFLUOROMETHANE
CONCENTRATION
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.3.8



Legend:

W-1 — Monitoring Well Location, Phase II, Stage 1

GW-1A — Monitoring Well Location, Phase II, Stage 2

Well Number
Well Location
Depth of Sample (ft)
Analyte Concentration

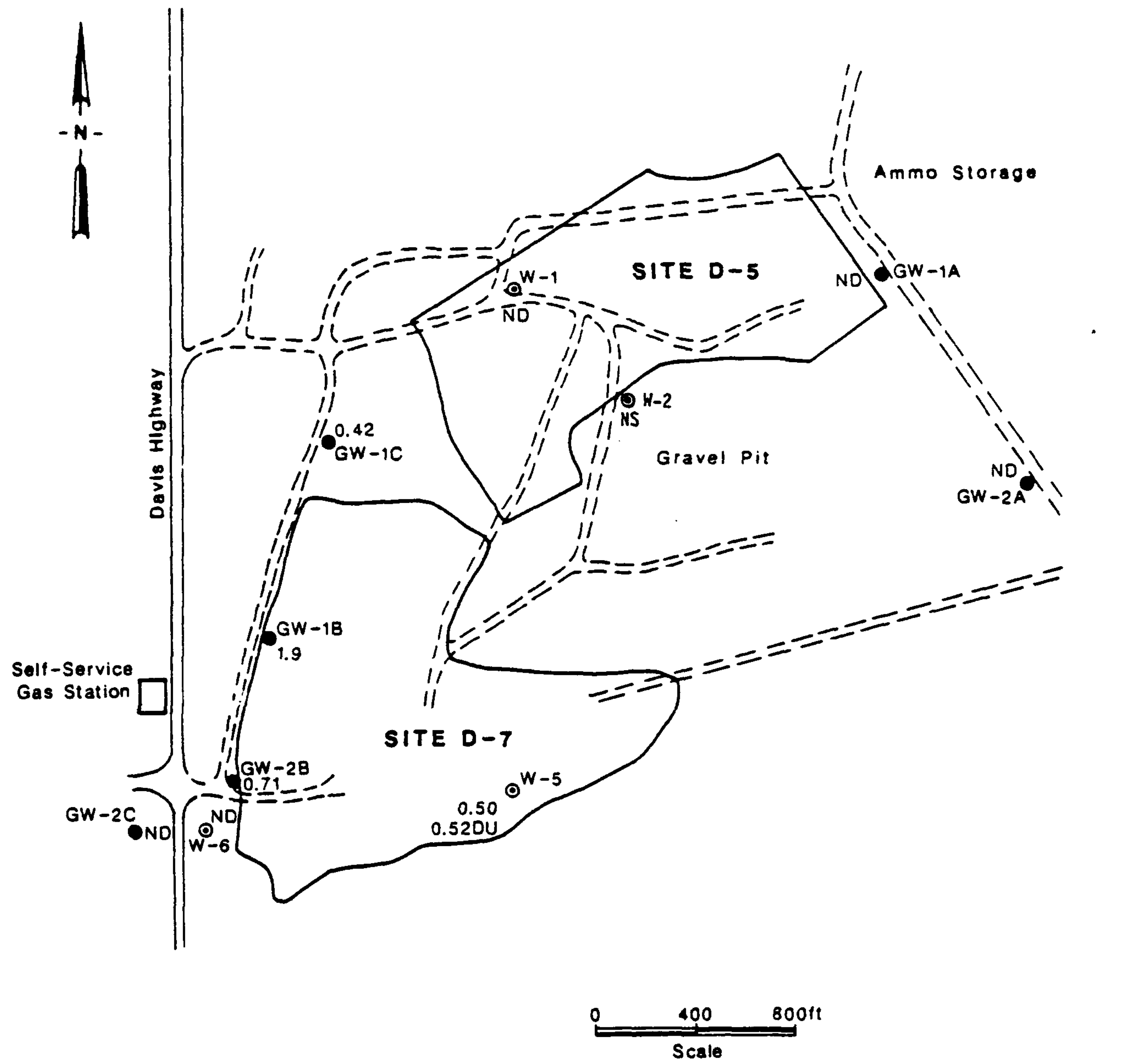
W-2 (Symbol) 10/300

[Water: µg/L
ND:Non-Detected
DU: Duplicate]
NS:Not Sampled

1,1,1-TRICHLOROETHANE
CONCENTRATION
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.3.9



Legend:

W-1 — Monitoring Well Location, Phase II, Stage 1

GW-1A — Monitoring Well Location, Phase II, Stage 2

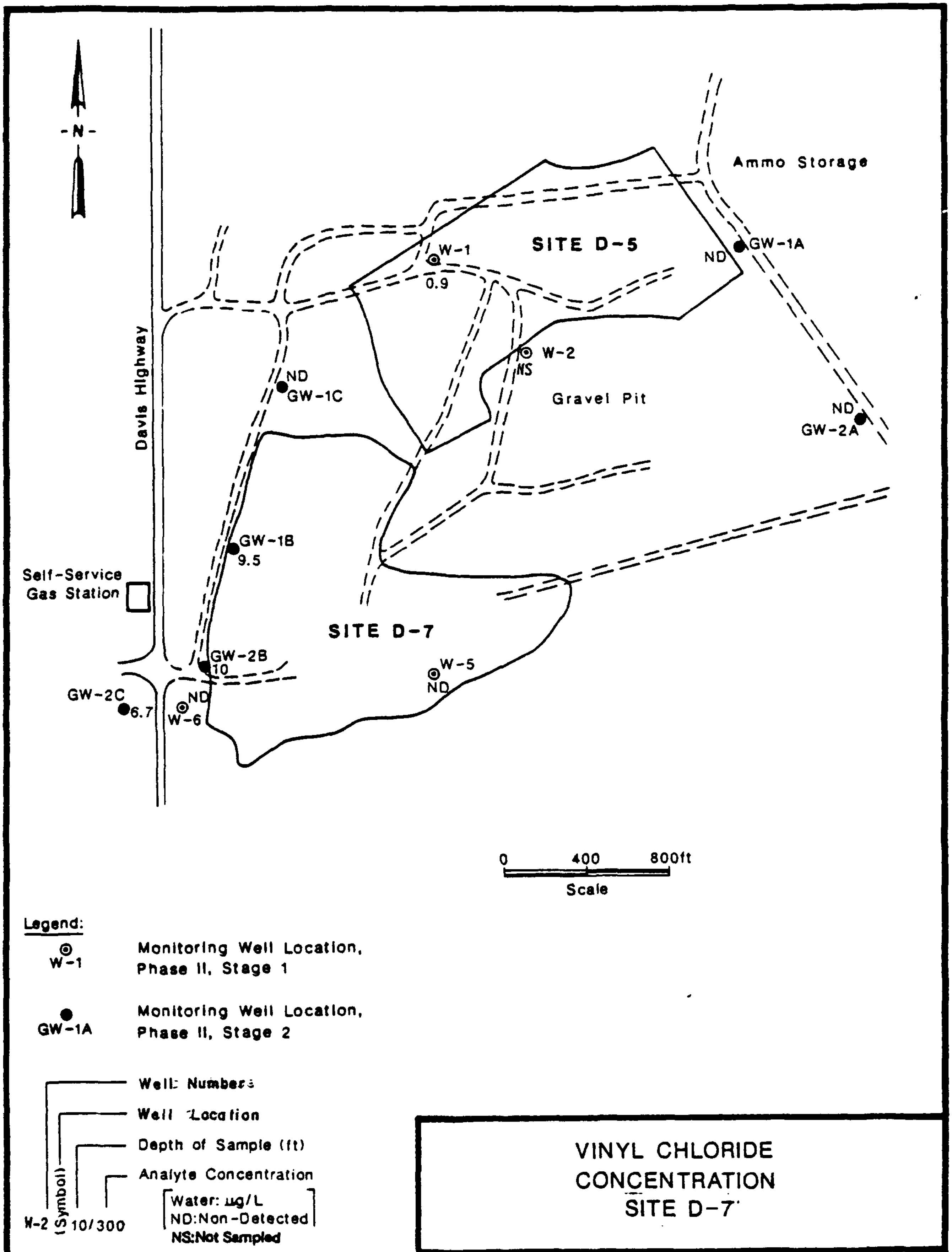
W-2 (Symbol) 10/300
- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration

Water: µg/L
ND: Non-Detected
DU: Duplicate
NS: Not Sampled

TETRACHLOROETHENE
CONCENTRATION
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

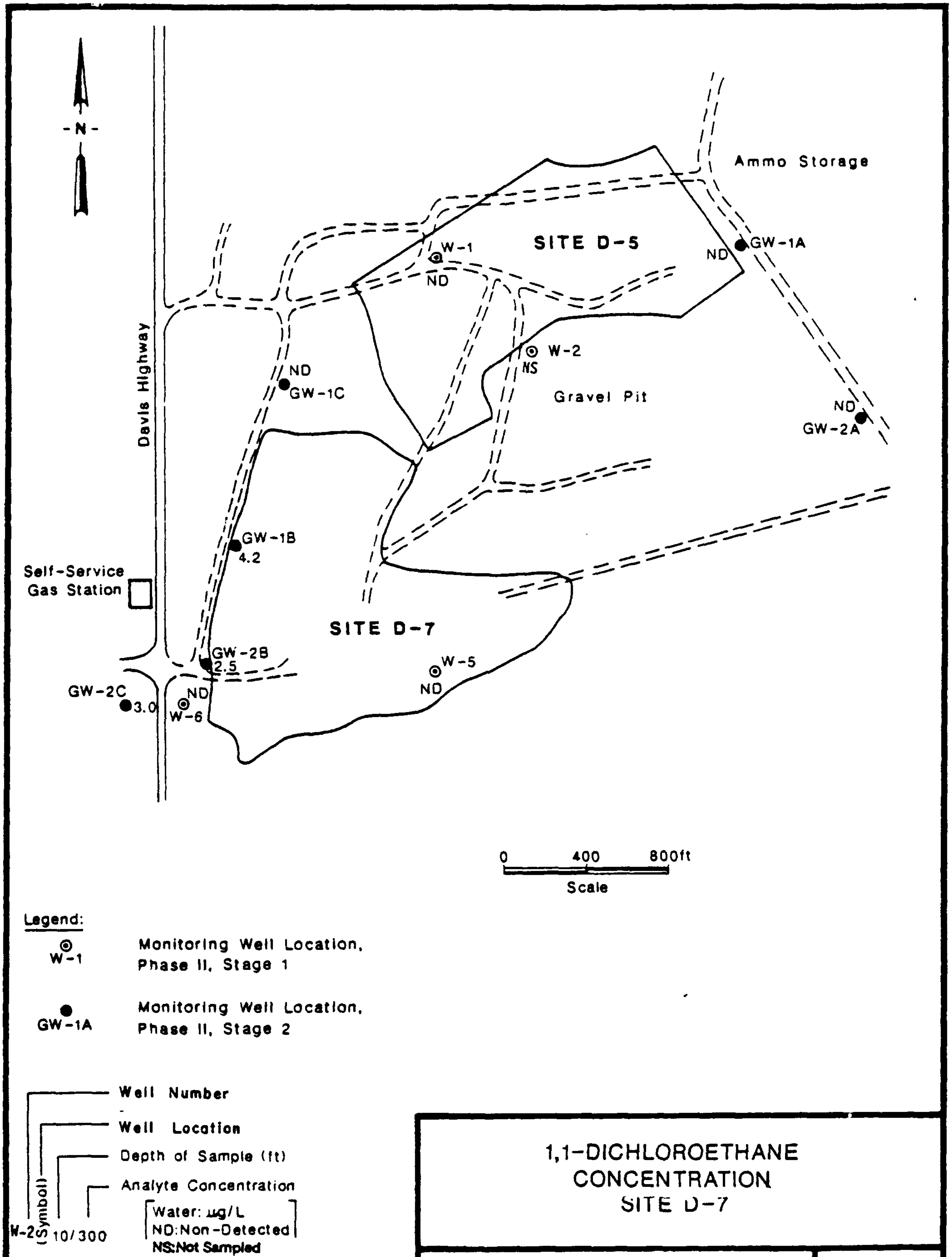
Figure
4.2.3.10.



VINYL CHLORIDE
CONCENTRATION
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

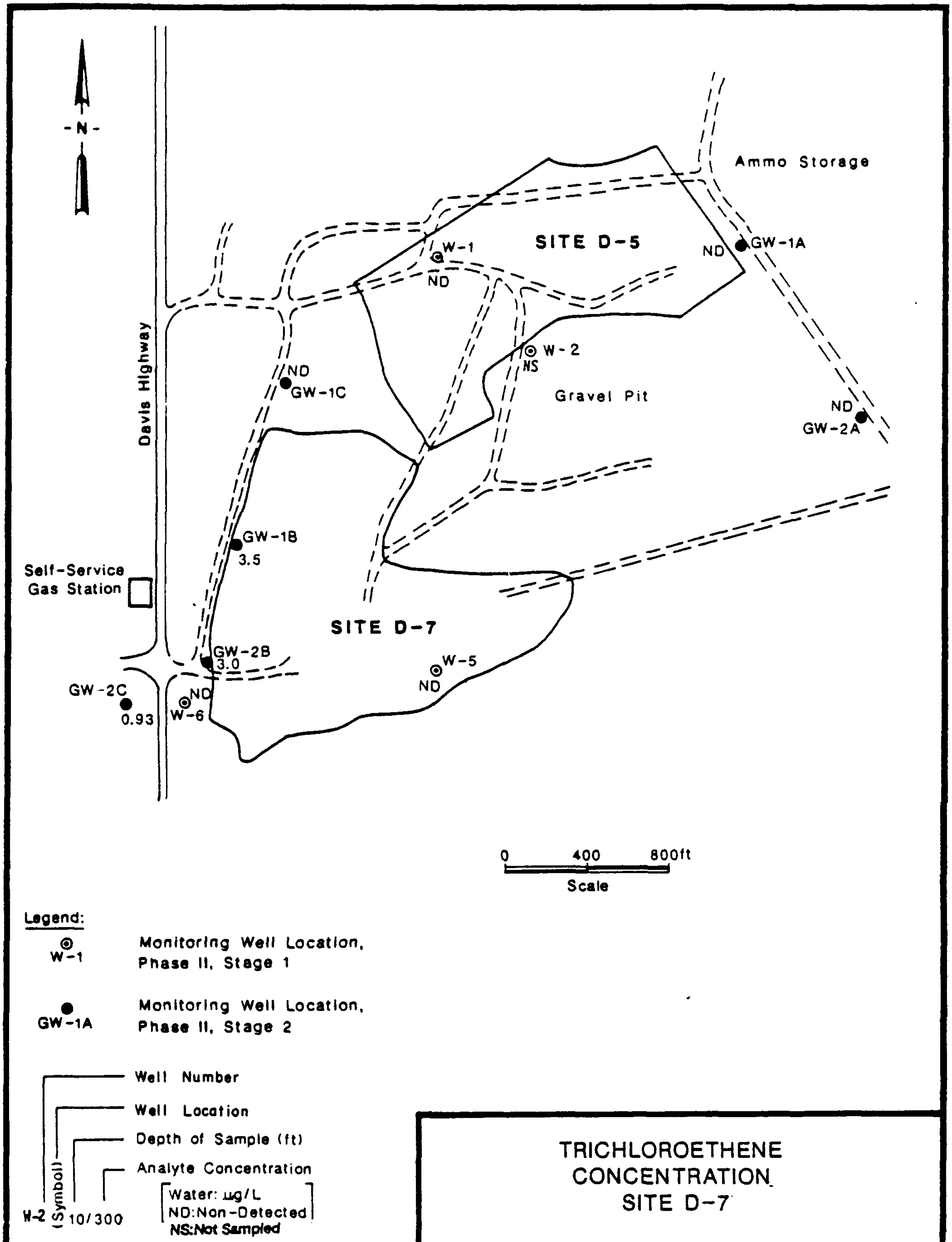
Figure
4.2.3.11



1,1-DICHLOROETHANE
CONCENTRATION
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

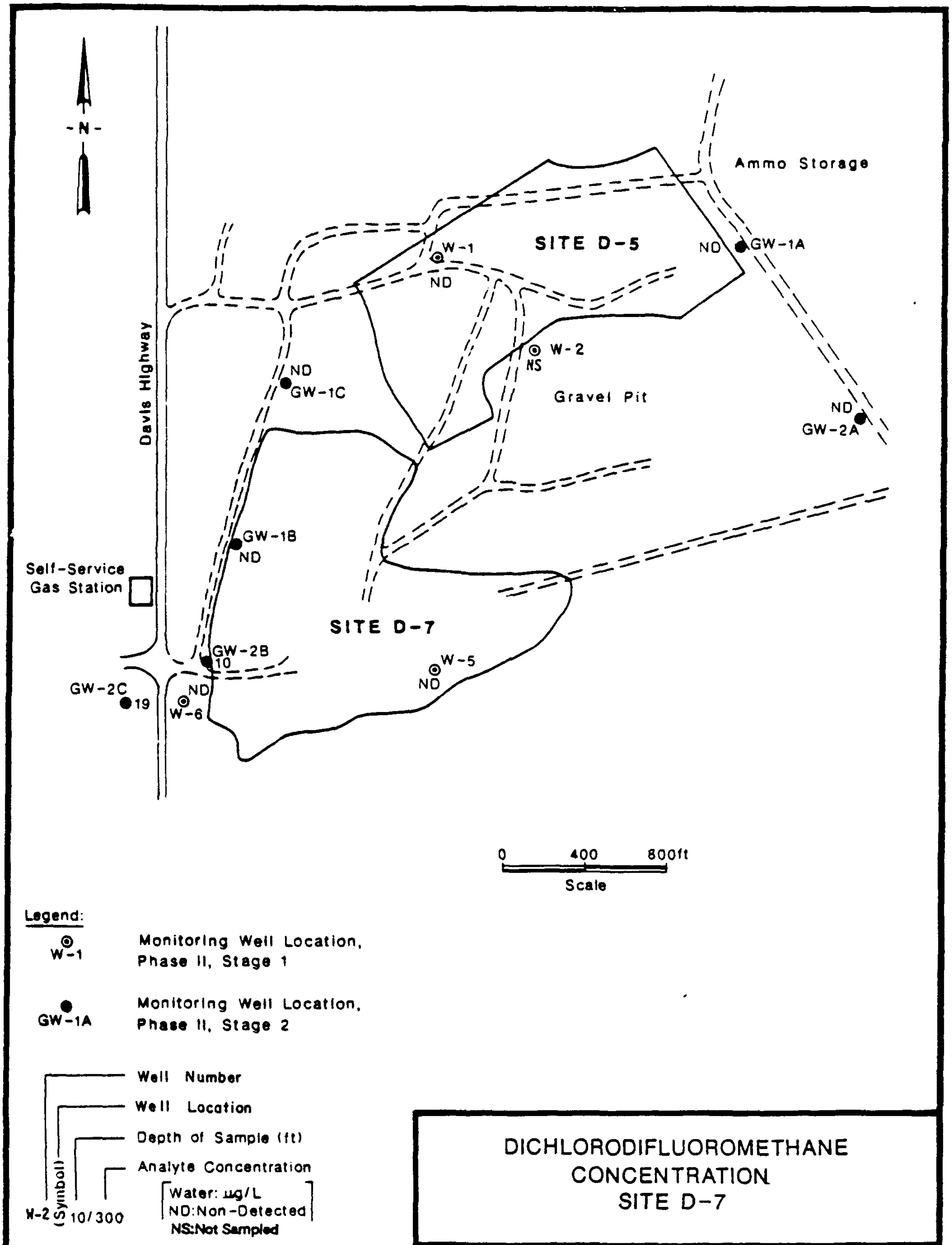
Figure
4.2.3.12



TRICHLOROETHENE CONCENTRATION SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.3.13



DICHLORODIFLUOROMETHANE
CONCENTRATION
SITE D-7

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.3.14

4.2.3.1.4 Analytical Results Table

All laboratory analytical results for detected parameters at Site D-7 are presented on Table 4.2.3.3.

Table 4.2.3.1 Field Parameters Site D-7

Well No.	Date Samples	Temperature (°C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
W-5	8/10/88	6.4	128	6.83	70	No odor or sheen
W-6	8/10/88	5.5	180	6.87	68	No odor or sheen
GW-1B	8/09/88	5.6	345	6.80	228	No odor or sheen
GW-2B	8/09/88	6.0	273	6.89	163	No odor or sheen
GW-2C	8/10/88	5.8	208	6.27	118	No odor or sheen

Table 4.2.3.2 Requested Laboratory Analyses for Samples from Site D-7

WATER

Test Number	Analysis
300	Common Anions
418.1	Petroleum Hydrocarbons
200.7	ICP Screen (total and dissolved)
206.2	Arsenic (total and dissolved)
239.2	Lead (total and dissolved)
245.1	Mercury (total dissolved)
270.2	Selenium (total and dissolved)
601	Purgeable Halocarbons
602	Purgeable Aromatics
625	Extractable Priority Pollutants

Table 4.2.3.3

Analytical Results - Site D-7

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-5 0687-NG-010,GN-88-0001 001206-0004	W-5 DUPLICATE 0687-NG-010,GN-88-0001D 001206-0004	W-5 RESAMPLE 0687-NG-010,GN-88-0001R 001278-0006	W-5 RESAMPLE DUPLICATE 0687-NG-010,GN-88-0001RD DU 001278-0006	W-5 GN840275	W-5 W-5-8	W-5 W-5/26
1,1,1-Trichloroethane	EPA 601	ug/L	200	0.21	0.26					
1,1-Dichloroethane	EPA 601	ug/L								
Benzene	EPA 602	ug/L	5.0							
Chloride	300.0	mg/L	250	2.0	1.7					
Chloroethane	EPA 601	ug/L								
Dichlorodifluoromethane	EPA 601	ug/L								
Dissolved Aluminum	200.7	mg/L					0.06			
Dissolved Arsenic	206.2	mg/L	0.05	0.004						
Dissolved Barium	200.7	mg/L	1.0			0.022	0.015			
Dissolved Calcium	200.7	mg/L				27.	25.			
Dissolved Chromium	200.7	mg/L	0.05							
Dissolved Cobalt	200.7	mg/L								
Dissolved Copper	200.7	mg/L	1.0							
Dissolved Iron	200.7	mg/L	0.3							
Dissolved Lead	239.2	mg/L	0.05	0.14	0.027					
Dissolved Magnesium	200.7	mg/L				4.8	4.4			
Dissolved Manganese	200.7	mg/L	0.05			0.072	0.084			
Dissolved Nickel	200.7	mg/L								
Dissolved Selenium	270.2	mg/L	0.01							
Dissolved Sodium	200.7	mg/L	250			4.2	3.6			
Dissolved Vanadium	200.7	mg/L								
Dissolved Zinc	200.7	mg/L	5.0			0.06	0.05			
Fluoride	300.0	mg/L	2.0							
METHYLENE CHLORIDE	601	ug/L								1.8
MOISTURE	GRAV.	%							3.1	
Nitrate as N	300.0	mg/L	10	0.7	0.6					
OIL & GREASE	413.2	mg/L						6		
Recoverable Aluminum	200.7	mg/L		7.8	7.2					
Recoverable Arsenic	206.2	mg/L	0.05	0.004	0.004					
Recoverable Barium	200.7	mg/L	1.0	0.15	0.15					
Recoverable Beryllium	200.7	mg/L	0.0000039							
Recoverable Calcium	200.7	mg/L		30.	30.					
Recoverable Chromium	200.7	mg/L	0.05	0.02	0.02					
Recoverable Cobalt	200.7	mg/L								
Recoverable Copper	200.7	mg/L	1.0	0.18	0.17					
Recoverable Iron	200.7	mg/L	0.3	11.	10.					
Recoverable Lead	239.2	mg/L	0.05	0.15	0.14					
Recoverable Magnesium	200.7	mg/L		7.5	7.5					
Recoverable Manganese	200.7	mg/L	0.05	0.74	0.73					
Recoverable Nickel	200.7	mg/L								
Recoverable Sodium	200.7	mg/L	250	5.1	5.2					
Recoverable Vanadium	200.7	mg/L		0.02	0.02					
Recoverable Zinc	200.7	mg/L	5.0	0.34	0.34					
Sulfate	300.0	mg/L	250	20.	18.					
TOC	415.1	mg/L						1		
TOX	9020	ug/L						80		
TRANS-1,2-DICHLOROETHENE	601	ug/L	70							
TRICHLOROFLUOROMETHANE	601	ug/L								0.99
Tetrachloroethene	EPA 601	ug/L	5.0	0.50	0.52					
Toluene	EPA 602	ug/L	2,000							
Total Dissolved Solids	160.1	mg/L	500		100.			220		
Total Mercury	245.1	mg/L	0.002	0.0002	0.0001					
Total Petroleum Hydrocarbons	418.1	mg/L								
Trichloroethene	EPA 601	ug/L	5.0							
Trichlorofluoromethane	EPA 601	ug/L								
Vinyl chloride	EPA 601	ug/L	2.0							

Table 4.2.3.3

Analytical Results - Site D-7

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-5 W-5/64	W-5 W-5/65	GW-1B 0687-NG-012 GN-88-0001 001240-0010	GW-1B 0687-NG-012 GN-88-0001R 001324-0006	GW-2B 0687-NG-013 GN-88-0001 001240-0007	GW-2B RESAMPLE 0687-NG-013 GN-88-0001R 001324-0007	GW-2B GW-2B/18
1,1,1-Trichloroethane	EPA 601	ug/L	200			36.		0.52		
1,1-Dichloroethane	EPA 601	ug/L				4.2		2.5		1.5
Benzene	EPA 602	ug/L	5.0					1.1		
Chloride	300.0	mg/L	250			9.3		14.		
Chloroethane	EPA 601	ug/L				9.5				
Dichlorodifluoromethane	EPA 601	ug/L						10.		
Dissolved Aluminum	200.7	mg/L				15.		5.5	0.08	
Dissolved Arsenic	206.2	mg/L	0.05			0.006	0.003	0.014	0.012	
Dissolved Barium	200.7	mg/L	1.0			0.25	0.17	0.11	0.22	
Dissolved Calcium	200.7	mg/L				109.	87.	54.	40.	
Dissolved Chromium	200.7	mg/L	0.05			0.01				
Dissolved Cobalt	200.7	mg/L				0.09		0.03	0.01	
Dissolved Copper	200.7	mg/L	1.0			0.27		0.14		
Dissolved Iron	200.7	mg/L	0.3			27.		37.	26.	
Dissolved Lead	239.2	mg/L	0.05			0.016		0.018		
Dissolved Magnesium	200.7	mg/L				26.	19.	13.	9.3	
Dissolved Manganese	200.7	mg/L	0.05			9.0		8.7	7.1	
Dissolved Nickel	200.7	mg/L				0.15		0.06		
Dissolved Selenium	270.2	mg/L	0.01				0.002			
Dissolved Sodium	200.7	mg/L	250			9.5	13.	9.5	14.	
Dissolved Vanadium	200.7	mg/L				0.05		0.04		
Dissolved Zinc	200.7	mg/L	5.0			0.11	0.12	0.04	0.07	
Fluoride	300.0	mg/L	2.0					1.9		
METHYLENE CHLORIDE	601	ug/L								3
MOISTURE	GRAV.	%								
Nitrate as N	300.0	mg/L	10							
OIL & GREASE	413.2	mg/L								
Recoverable Aluminum	200.7	mg/L				43.		20.		
Recoverable Arsenic	206.2	mg/L	0.05			0.004		0.020		
Recoverable Barium	200.7	mg/L	1.0			0.46		0.24		
Recoverable Beryllium	200.7	mg/L	0.0000039							
Recoverable Calcium	200.7	mg/L				109.		55.		
Recoverable Chromium	200.7	mg/L	0.05			0.08		0.03		
Recoverable Cobalt	200.7	mg/L				0.09		0.04		
Recoverable Copper	200.7	mg/L	1.0			0.32		0.21		
Recoverable Iron	200.7	mg/L	0.3			87.		59.		
Recoverable Lead	239.2	mg/L	0.05					0.028		
Recoverable Magnesium	200.7	mg/L				40.		19.		
Recoverable Manganese	200.7	mg/L	0.05			8.1		8.4		
Recoverable Nickel	200.7	mg/L				0.21		0.11		
Recoverable Sodium	200.7	mg/L	250			10.		9.1		
Recoverable Vanadium	200.7	mg/L				0.15		0.09		
Recoverable Zinc	200.7	mg/L	5.0			0.22		0.09		
Sulfate	300.0	mg/L	250					0.9		
TOC	415.1	mg/L								
TOX	9020	ug/L								
TRANS-1,2-DICHLOROETHENE	601	ug/L	70							6.9
TRICHLOROFLUOROMETHANE	601	ug/L								1.3
Tetrachloroethene	EPA 601	ug/L	5.0			1.9		0.71		
Toluene	EPA 602	ug/L	2,000					1.0		
Total Dissolved Solids	160.1	mg/L	500	130						
Total Mercury	245.1	mg/L	0.002			0.0006		0.0005		
Total Petroleum Hydrocarbons	418.1	mg/L			3.9					
Trichloroethene	EPA 601	ug/L	5.0			3.5		3.0		2.3
Trichlorofluoromethane	EPA 601	ug/L				49.				
Vinyl chloride	EPA 601	ug/L	2.0			9.5		10.		

Table 4.2.3.3

Analytical Results - Site D-7

Parameter	Method	Units	Standards, Criteria and Action Levels	GW-2B	W-6	W-6 RESAMPLE	W-6	W-6	W-6	W-6	W-6
			Federal/State	GW-2B/80	0687-NG-011,GN-88-0001 001206-0005	0687-NG-011,GN-88-0001R 001278-0007	GN840276	W-6-8	W-6/55	W-6/56	W-6B/25
1,1,1-Trichloroethane	EPA 601	ug/L	200								
1,1-Dichloroethane	EPA 601	ug/L									
Benzene	EPA 602	ug/L	5.0								
Chloride	300.0	mg/L	250		1.8						
Chloroethane	EPA 601	ug/L									
Dichlorodifluoromethane	EPA 601	ug/L									
Dissolved Aluminum	200.7	mg/L									
Dissolved Arsenic	206.2	mg/L	0.05		0.027						
Dissolved Barium	200.7	mg/L	1.0			0.005					
Dissolved Calcium	200.7	mg/L				22.					
Dissolved Chromium	200.7	mg/L	0.05								
Dissolved Cobalt	200.7	mg/L									
Dissolved Copper	200.7	mg/L	1.0								
Dissolved Iron	200.7	mg/L	0.3								
Dissolved Lead	239.2	mg/L	0.05		0.15						
Dissolved Magnesium	200.7	mg/L				3.9					
Dissolved Manganese	200.7	mg/L	0.05			0.58					
Dissolved Nickel	200.7	mg/L									
Dissolved Selenium	270.2	mg/L	0.01								
Dissolved Sodium	200.7	mg/L	250			3.0					
Dissolved Vanadium	200.7	mg/L									
Dissolved Zinc	200.7	mg/L	5.0								
Fluoride	300.0	mg/L	2.0								
METHYLENE CHLORIDE	601	ug/L									
MOISTURE	GRAV.	%						26			
Nitrate as N	300.0	mg/L	10								
OIL & GREASE	413.2	mg/L					1				
Recoverable Aluminum	200.7	mg/L			26.						
Recoverable Arsenic	206.2	mg/L	0.05		0.016						
Recoverable Barium	200.7	mg/L	1.0		0.20						
Recoverable Beryllium	200.7	mg/L	0.0000039								
Recoverable Calcium	200.7	mg/L			31.						
Recoverable Chromium	200.7	mg/L	0.05		0.07						
Recoverable Cobalt	200.7	mg/L			0.04						
Recoverable Copper	200.7	mg/L	1.0		0.11						
Recoverable Iron	200.7	mg/L	0.3		67.						
Recoverable Lead	239.2	mg/L	0.05		0.10						
Recoverable Magnesium	200.7	mg/L			17.						
Recoverable Manganese	200.7	mg/L	0.05		6.0						
Recoverable Nickel	200.7	mg/L			0.09						
Recoverable Sodium	200.7	mg/L	250		4.5						
Recoverable Vanadium	200.7	mg/L			0.10						
Recoverable Zinc	200.7	mg/L	5.0		0.12						
Sulfate	300.0	mg/L	250		14.						
TOC	415.1	mg/L									
TOX	9020	ug/L					44				
TRANS-1,2-DICHLOROETHENE	601	ug/L	70								
TRICHLOROFLUOROMETHANE	601	ug/L									0.56
Tetrachloroethene	EPA 601	ug/L	5.0								
Toluene	EPA 602	ug/L	2,000								
Total Dissolved Solids	160.1	mg/L	500	190			82		90		
Total Mercury	245.1	mg/L	0.002		0.0008						
Total Petroleum Hydrocarbons	418.1	mg/L								0.7	
Trichloroethene	EPA 601	ug/L	5.0								
Trichlorofluoromethane	EPA 601	ug/L									
Vinyl chloride	EPA 601	ug/L	2.0								

Table 4.2.3.3

Analytical Results - Site D-7

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	GW-2C 0687-NG-014,GW-88-0001 001206-0006	GW-2C RESAMPLE 0687-NG-014,GW-88-0001R 001278-0008	GW-2C GW-2C/19	GW-2C GW-2C/61	GW-2A GW-2A/20	GW-2A GW-2A/58
1,1,1-Trichloroethane	EPA 601	ug/L	200						
1,1-Dichloroethane	EPA 601	ug/L		3.0		3.5			
Benzene	EPA 602	ug/L	5.0						
Chloride	300.0	mg/L	250	13.					
Chloroethane	EPA 601	ug/L							
Dichlorodifluoromethane	EPA 601	ug/L		19.					
Dissolved Aluminum	200.7	mg/L							
Dissolved Arsenic	206.2	mg/L	0.05	0.031	0.003				
Dissolved Barium	200.7	mg/L	1.0		0.032				
Dissolved Calcium	200.7	mg/L			37.				
Dissolved Chromium	200.7	mg/L	0.05						
Dissolved Cobalt	200.7	mg/L			0.02				
Dissolved Copper	200.7	mg/L	1.0						
Dissolved Iron	200.7	mg/L	0.3		4.8				
Dissolved Lead	239.2	mg/L	0.05	0.040					
Dissolved Magnesium	200.7	mg/L			8.4				
Dissolved Manganese	200.7	mg/L	0.05		7.6				
Dissolved Nickel	200.7	mg/L			0.02				
Dissolved Selenium	270.2	mg/L	0.01						
Dissolved Sodium	200.7	mg/L	250		11.				
Dissolved Vanadium	200.7	mg/L							
Dissolved Zinc	200.7	mg/L	5.0		0.02				
Fluoride	300.0	mg/L	2.0						
METHYLENE CHLORIDE	601	ug/L				31		0.8	
MOISTURE	GRAV.	%							
Nitrate as N	300.0	mg/L	10						
OIL & GREASE	413.2	mg/L							
Recoverable Aluminum	200.7	mg/L		73.					
Recoverable Arsenic	206.2	mg/L	0.05	0.022					
Recoverable Barium	200.7	mg/L	1.0	0.87					
Recoverable Beryllium	200.7	mg/L	0.0000039	0.003					
Recoverable Calcium	200.7	mg/L		80.					
Recoverable Chromium	200.7	mg/L	0.05	0.21					
Recoverable Cobalt	200.7	mg/L		0.13					
Recoverable Copper	200.7	mg/L	1.0	0.74					
Recoverable Iron	200.7	mg/L	0.3	179.					
Recoverable Lead	239.2	mg/L	0.05	0.065					
Recoverable Magnesium	200.7	mg/L		50.					
Recoverable Manganese	200.7	mg/L	0.05	15.					
Recoverable Nickel	200.7	mg/L		0.46					
Recoverable Sodium	200.7	mg/L	250	13.					
Recoverable Vanadium	200.7	mg/L		0.28					
Recoverable Zinc	200.7	mg/L	5.0	0.34					
Sulfate	300.0	mg/L	250	7.4					
TOC	415.1	mg/L							
TOX	9020	ug/L							
TRANS-1,2-DICHLOROETHENE	601	ug/L	70			3.1			
TRICHLOROFLUOROMETHANE	601	ug/L				1.2			
Tetrachloroethene	EPA 601	ug/L	5.0						
Toluene	EPA 602	ug/L	2,000						
Total Dissolved Solids	160.1	mg/L	500				210		140
Total Mercury	245.1	mg/L	0.002	0.0008					
Total Petroleum Hydrocarbons	418.1	mg/L							
Trichloroethene	EPA 601	ug/L	5.0	0.93		0.66			
Trichlorofluoromethane	EPA 601	ug/L							
Vinyl chloride	EPA 601	ug/L	2.0	6.7					

4.2.3.1.5 Discussion of Analytical Data

Volatile organic compounds including toluene (1.0 ug/L) and benzene (1.1 ug/L) were detected in a water sample from well GW-2B. Chlorinated hydrocarbons were prevalent in samples from the site (Figures 4.2.3.7 through 4.2.3.14). However, the concentrations detected were generally low. Trichloroethene was detected in samples from wells GW-2C, GW-2B, and GW-1B at concentrations ranging from 0.93 to 3.5 ug/L. 1,1-dichloroethane and vinyl chloride were also detected in these 3 wells, at concentrations ranging from 2.5 to 4.2 ug/L, and 6.7 to 10 ug/L, respectively. Tetrachloroethene (0.5 to 1.9 ug/L) and 1,1,1-trichloroethane (0.21 to 36 ug/L) were detected in water from wells GW-1B, GW-2B, and W-5. Chloroethane and trichlorofluoromethane were detected in well GW-1B at concentrations of 9.5 and 49 ug/L, respectively. Dichlorofluoromethane was found in water from wells GW-2C and GW-2B at 19 and 10 ug/L, respectively; total petroleum hydrocarbons (0.6 mg/L) were detected only in well GW-2C.

Metals such as aluminum (7.8 to 73 mg/L), iron (11 to 179 mg/L), manganese (0.74 to 15 mg/L) and magnesium (7.5 to 50 mg/L) were detected as total recoverable metals in water samples from the site. In all cases the lowest concentrations were found to the west at well W-5 and the highest to the east at well GW-2C. The second highest concentration for these metals were found at well GW-1B to the north. Dissolved metals ranged in concentration from 0.005 mg/L for barium to 26 mg/L for iron.

Total recoverable calcium (30 to 109 mg/L), sodium (4.5 to 13 mg/L), sulfate (0.9 to 20 mg/L) and chloride ions (1.8 to 14 mg/L) were detected in water from Site D-7. Fluoride ions were detected in a water sample from well GW-2B at a concentration of 1.9 mg/L.

Small amounts of other total recoverable elements such as barium, chromium, copper, lead, vanadium and zinc were detected in water samples from all wells. Barium and copper were detected at concentrations less than 0.5 mg/L in water from wells W-5, W-6, GW-1B and GW-2B. The concentrations of barium and copper were slightly higher, 0.87 and 0.74 mg/L, respectively, in a sample from well GW-2C. Total recoverable chromium concentrations ranged from 0.02 mg/L in well W-5 to 0.21 mg/L in well GW-2C. A wide range of total recoverable vanadium concentrations was also detected, from 0.02 mg/L in well W-5 to 0.28 mg/L in well number GW-2C. Zinc concentrations were found to be less than 0.5 mg/L in all wells. Lead concentrations ranged from 0.028 mg/L in well GW-2B to 0.15 mg/L in well W-5. Nickel was detected in all wells at concentrations less than 0.5 mg/L except well W-5.

Trace amounts of arsenic (less than 0.05 mg/L) and mercury (less than 0.002 mg/L) were detected in water samples from all wells at Site D-7. Trace amounts of total recoverable cobalt (less than 0.05 mg/L) were detected in water samples from all wells except Well W-5. Beryllium was detected at a concentration of 0.003 mg/L in a sample from well GW-2C.

4.2.3.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site D-7 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.3.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis were lost from Site D-7.

4.2.3.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is possible, but unlikely, that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures and cross-contamination were detected in samples from the site.

4.2.3.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Five previously-installed wells were sampled at Site D-7. All of the samples to be tested for dissolved metals were not originally filtered in the field. This was corrected by resampling the 5 wells for dissolved metals only, and filtering the samples on site prior to shipment.

4.2.3.2.4 Corrective Actions Applied to Out-of-Control Events, Including a Chronology of Rerunning Samples and Controls

All 5 wells at Site D-7 were resampled for dissolved metals. The following table shows when sampling and resampling activities were conducted.

Table 4.2.3.4 Resampling Dates - Dissolved Metals Analysis

Well Number	Original Sampling Date	Resampling Date
W-5	8/10/88	8/15/88
W-6	8/10/88	8/15/88
GW-1B	8/9/88	8/19/88
GW-2B	8/9/88	8/19/88
GW-2C	8/9/88	8/19/88

4.2.3.3 Significance of Findings for Site D-7

Analytical results for water samples from Site D-7 showed contamination by various organic compounds. Vinyl chloride, detected in water samples from the site, exceeded current EPA MCLs. Total recoverable values of lead and chromium also exceeded MCLs. There is evidence that the majority of the metals in the groundwater are suspended, and therefore possibly due to the presence of soils in the groundwater. However, the presence of metals above MCLs cannot be disregarded as a soil phenomenon at this site with current data.

A study done by Dames and Moore (1987) detected 1,1-dichloroethane, trans-1,2-dichloroethene, trichloroethene and trichlorofluoromethane in water samples from these wells.

The source of these volatile organic compounds in the groundwater is most likely shop wastes and buried drums containing unknown wastes. Basic receptors are humans, wildlife, and plants. Pathways of exposure to the receptors of these metals include ingestion of groundwater by humans and wildlife. Plants that have recolonized disturbed areas may be impacted by contamination in the soils. Plants in the marginal areas are less likely to be affected due to the depth of groundwater (over 35 feet).

4.2.3.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. Wells GW-1B and GW-2B, located downgradient from well number W-5, contained vinyl chloride, trichlorofluoromethane (Freon-11), trichloroethene, tetrachloroethene, dichlorodifluoromethane, and/or benzene. A 1986 sample from well GW-1B also contained trichloroethene and tetrachloroethene and a 1986 sample from well GW-2B contained trichloroethene. These 1986 concentrations were lower

than those detected during this study. The most downgradient well, well GW-2C, contained dichlorodifluoromethane and vinyl chloride. A 1986 sample from well GW-2C did not contain these compounds.

The most upgradient well, well W-6, and well W-5 located to the east and downgradient, showed the least amount of contamination. These wells were drilled at least 10 feet deeper, and a year earlier, than the other, more contaminated wells at Site D-7.

4.2.3.3.2 Contaminant Migration

The primary migration medium at Site D-7 is groundwater. Water samples collected in 1986 and 1988 from well GW-2C, a down-gradient and offsite well, were contaminated with chlorinated organic compounds. A well located within the landfill, well GW-1B, was contaminated with Freon-11 and other chlorinated organics. Well D13-03 (see Section 4.2.4), was also contaminated with organic compounds including Freon-11. Contamination levels detected in this well were lower than those detected in well GW-1B. Well D13-03 is downgradient of well GW-1B and outside of the estimated boundaries of the landfill. Historically, 1,1-dichloroethane is used as a solvent and as a fumigant. 1,2-dichloroethene is used as a general solvent for organic materials; dye extraction; perfumes; lacquers; thermoplastics; and organic synthesis. Quite possibly, 1,1-dichloroethane and 1,2-dichloroethene are present in Site D-7 as a degradation product of tetrachloroethene or trichloroethene. Trichloroethene is commonly used as a solvent and degreaser. Trichlorofluoromethane (Freon-11) is used as a refrigerent and as a propellent in aerosol containers. Trichloroethene and Freon-11 are still used at Elmendorf AFB.

4.2.3.3.2.1 Potential for Offsite and Off-Base Migration

Offsite migration is occurring at Site D-7. Historic records suggest that well GW-2C is clearly outside and downgradient of the landfill boundary. This well was found to be contaminated at levels above EPA MCLs for vinyl chloride. Wells GW-1B and GW-2B are within the assumed landfill boundaries. These 2 wells were contaminated with several organic compounds several compounds not detected in well GW-2C. Freon-11 also appears to be migrating offsite as indicated by the concentrations of this compound in the offsite and downgradient well D13-03. Well W-5 are situated within the landfill boundary, and well W-6 were not contaminated by organic compounds. In 1986, samples from these wells contained Freon-11.

4.2.3.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site identified the direction of groundwater flow to be to the west-northwest, with a gradient of about 20 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, point of release to the groundwater, and factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated.

4.2.3.3.2.3 Time of Travel to Receptors

Primary receptors are humans, plants, and wildlife. The primary pathway to the receptors is through contaminated groundwater. An active downgradient drinking well (base well 42) is located about 5200 feet northwest of Site D-7 at building 11-200. The hydraulic conductivity has not been determined at this site; thus, travel time to the well cannot be estimated. However, base well 42 is an artesian

well, drilled to a depth of 225 feet (Phase II, Stage 2 Report, Dames and Moore, 1987). The water from base well 42 is contained inside a casing as it flows through the zone of contamination detected at Site D-7, but and is unlikely to be affected by impacts from the site. A gravel pit less than 500 feet north of the site has the potential to expose groundwater during gravel-removal operations. Although the gravel pit is upgradient of the landfill boundaries, seasonal and/or temporal factors may allow contamination to diffuse in that direction, or expansion of the pit may extend into areas downgradient of the landfill boundaries. Time of travel to this pathway is negligible.

4.2.3.3.2.5 Expected Spatial and Temporal Variations in Concentration

The spacial extent of contamination past the site boundaries reaches at least to well GW-2C, which is about 500 feet northwest of what is estimated to be the site boundary. Due to contaminant concentrations that are well above detection limits in well GW-2C and a groundwater flow direction to the west-northwest, contamination probably extends to the northwest past the well.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of the metals is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.3.3.3 Baseline Risk Assessment

An evaluation of the contamination present with reference to exposure pathways, presence of receptors, and health effects is presented in the following sections.

4.2.3.3.3.1 Waste Characterization

The primary wastes at this site are organic compounds. Benzene is a known human carcinogen. Vinyl chloride is used in plastics and as a refrigerant and has been listed as a human carcinogen by the EPA. Trichloroethene and tetrachloroethane are used as solvents for oils and paints and are also animal carcinogens. Trichlorofluoromethane (Freon-11) is used as an aerosol propellant, and is a suspected human carcinogen. Nickel has numerous industrial uses including the manufacture of stainless steels, electrical contacts, electrodes and other machinery parts. It is also a suspected human carcinogen.

Dichlorofluoromethane is used as a refrigerant and aerosol propellant. This compound may be narcotic at high concentrations, but is generally considered to have little toxic effects.

4.2.3.3.3.2 Source and Release Characterization

Organics are released to the groundwater from shop wastes and residue remaining in buried drums.

4.2.3.3.3.3 Fate and Transport of Contaminants

The fate of organic chemicals released into the environment at Site D-7 includes long-term natural degradation, dispersion through surface runoff or ground water, or uptake by living organisms. Transport of contaminants may have occurred by leaching into the water from debris buried at Site D-7.

Evidence of contaminant migration is apparent at the site. Offsite well GW-2C and well D13-03 were contaminated with several organic compounds and metals that were detected in water from wells within the assumed landfill boundary. The actual rate of flow, plume dimensions and precise direction of contamination migration are not known for this site.

The drinking water well at building 11-200 (base well 42) was last tested for metals in 1987. It was not tested for volatile organic compounds at that time. All metals were detected at levels less than State of Alaska and EPA water quality requirements.

4.2.3.3.3.4 Exposure Pathways

The primary pathways of exposure are ingestion of or contact with contaminated groundwater, plants or wildlife.

4.2.3.3.3.5 Identification of Receptors

Human receptors include any one drinking from the active well number 42 in the area if it is contaminated.

Wildlife may be exposed through the ingestion of any contaminated water that may be exposed during gravel extraction operations adjacent to the site.

4.2.3.3.3.6 Threat to Human Health

The most significant potential threat to human health is the drinking water from base well 42, should contamination be detected in this well. However this threat is slight due to the well design, deep artesian source and its distance from Site D-7.

4.2.3.3.3.7 Carcinogenetic Risks

Several metals suspected to be human carcinogens were detected in water samples from Site D-7 at concentrations higher than recommended State of Alaska and EPA levels. Benzene was detected in well number GW-2B at a concentration of 1.1 ug/L; the EPA NAWQC is 0.66 ug/L. However, benzene is below the MCL of 5 ug/L. Vinyl chloride was detected in samples from wells number GW-2B, GW-1B, and GW-2C at

concentrations up to 5 times the NAWQC and MCL of 2.0 ug/L. Both benzene and vinyl chloride are known human carcingens.

Trichloroethene, a probable human carcinogen (EPA Group B2), was detected in wells GW-1B and GW-2B at levels of 3.0 and 3.5 ug/L; these values are slightly over the NAWQC of 2.8 ug/L but below the MCL of 5 ug/L. Well GW-1B contained about twice as much tetrachloroethane as the EPA NAWQC of 0.88 mg/L. However, it was below the MCL of 5 ug/L. Tetrachloroethene is also an EPA Group B2 probable human carcinogen.

4.2.3.3.3.8 Threat to Wildlife

The primary area in which wildlife could be exposed is at the gravel pit to the northeast of the site. However, the quantity of ground water exposed by the removal of gravel has not been determined and is expected to change seasonally. Also, the major groundwater flow direction is to the west-northwest, but contaminated groundwater may be exposed if flow conditions change, or if the pit should extend into areas of the site. It is not known if any exposed water would be contaminated by sources identified at Site D-7. The threat to wildlife from contamination at the site is assessed as low.

4.2.3.4 Prioritization of Sites for Remedial Alternatives

Site D-7 is assigned a high-priority site for remedial alternatives due to the exceeding of State of Alaska water quality regulations, and the evidence of offsite migration. It is recommended that sites D-5, D-7, D-13 and NS-2 be combined due to their proximity and the similarity of the contaminants found at these sites. This new site would be assigned a high priority for remedial alternatives due to contaminated levels exceeding State of Alaska water quality

regulations and the evidence of offsite migration. Recommendations for further investigation at the combined site are described under Results for Site NS-2, DRMO Scrap Pile in Section 4.2.21.4.

4.2.4 Results for Site D-13, Disposal Site

Site D-13 (see Figure 4.2.4.1) is an old gravel pit which had been used as a disposal site from 1967 to 1971. The 2-acre site was used to dispose of empty drums, metal piping, drums full of asphalt, and small quantities of quicklime (Engineering-Science, 1983).

The site is covered with second-growth cottonwood, alders, willow and grass except where it has been recently cleared.

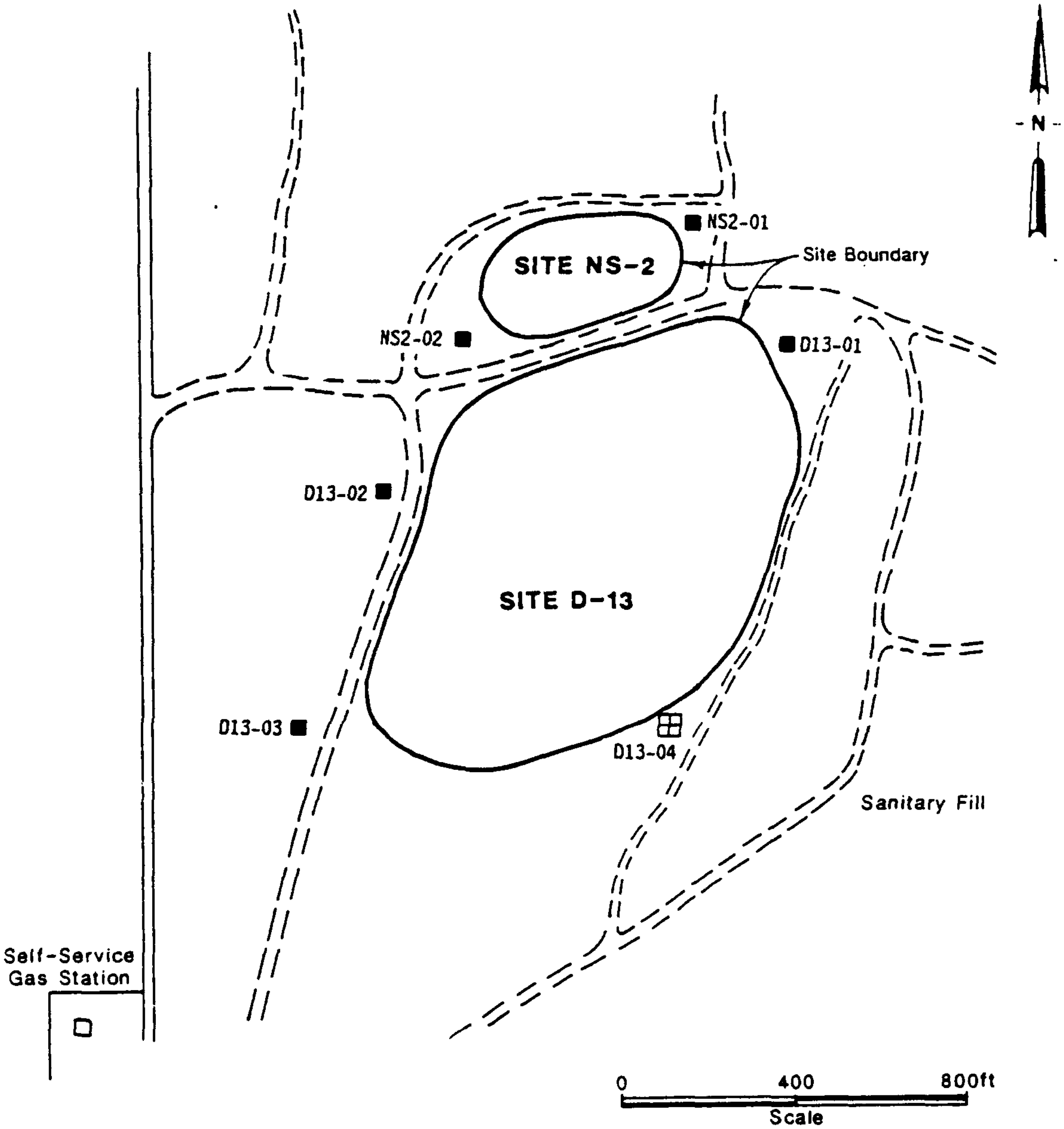
4.2.4.1 Presentation of Results at Site D-13

Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site maps.

4.2.4.1.1 Site Geology

Site D-13 is located at an elevation of 210 feet on flat terrain and is underlain by late-Quaternary glacial outwash deposits consisting chiefly of coarse sands and gravels with some silt. Based on information obtained from borings at other sites, it is assumed that the deposits overlie silty and clayey units of the Bootlegger Cove Formation at a depth exceeding 60 feet. Borehole logs for all sites included in the Base-wide field investigation program are presented in Appendix C. A schematic geologic cross section is presented on Figure 4.2.4.2. Interpretations of gamma logs are included in Appendix D.

A records review of 1965 and pre-1965 aerial photography indicates that significant portions of the site which are not vegetated were used as a landfill. Based on terrain conductivity survey results (see Figure 4.2.4.3), the northeastern half of the site outside the present gravel pit area appears to contain metallic debris of varying



Legend:

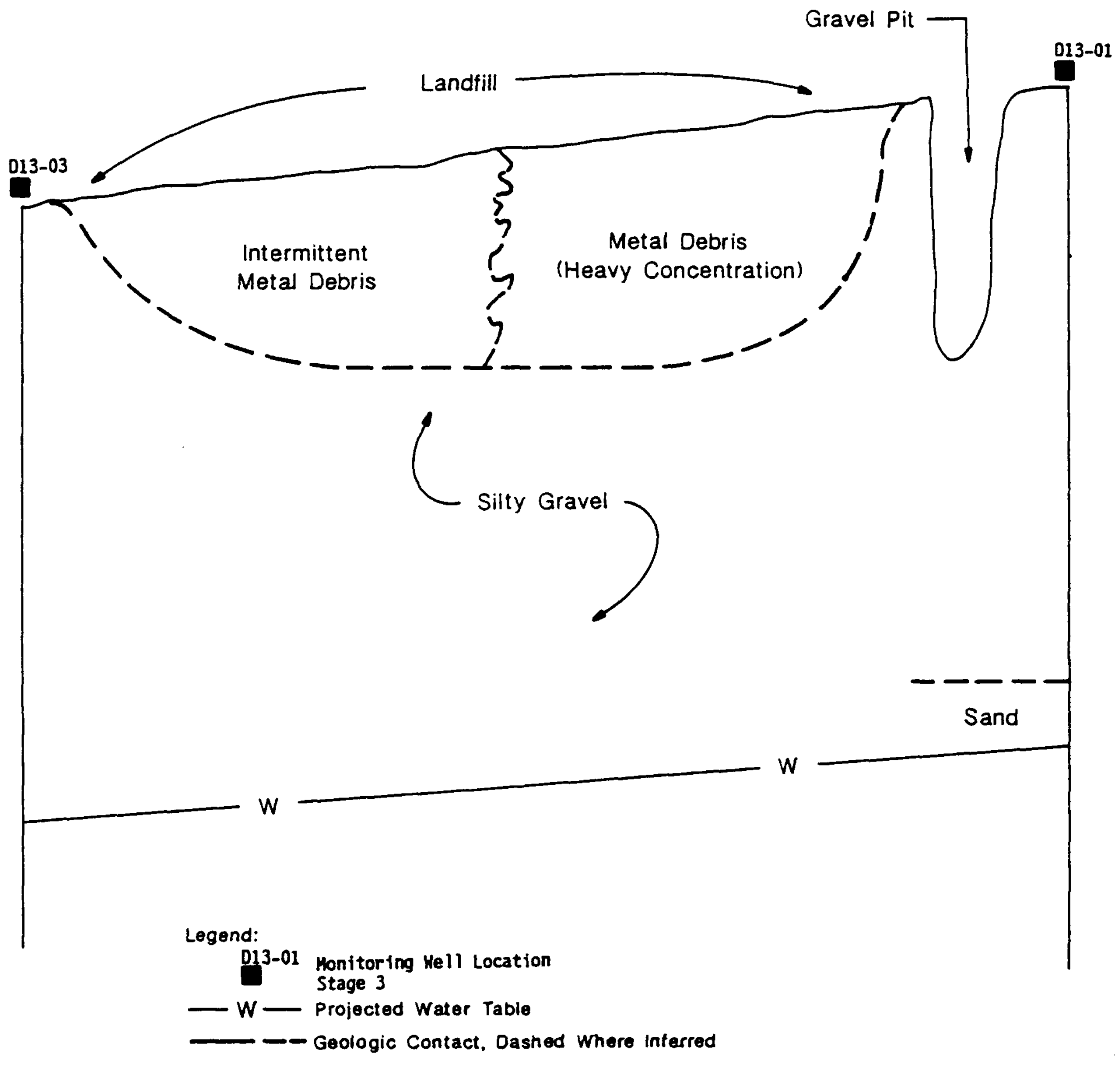
D13-02 ■ Monitoring Well Location Stage 3

⊞ D13-04 Stage 3 Borehole

LOCATION MAP
SITES D-13 & NS-2

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.4.1



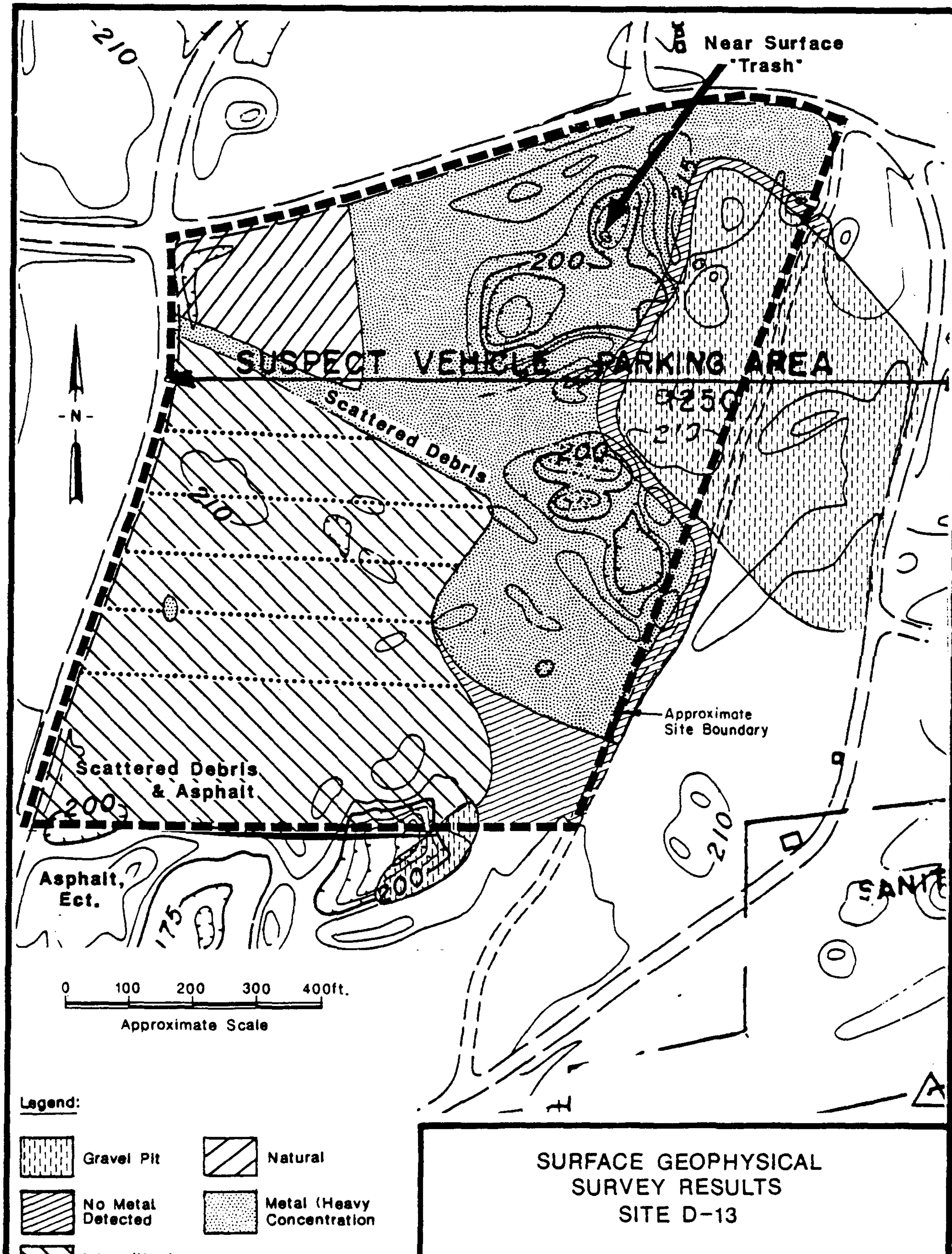
Notes:

1. Horizontal scale: 1 inch = 200 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Cross section shown on Figure 4.2.4.4
4. Based on geophysical data interpretation and test boring logs.

GEOLOGIC CROSS SECTION
SITE D-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.4.2



SURFACE GEOPHYSICAL SURVEY RESULTS SITE D-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.4.3

quantities, excluding a small area of natural ground within the northwest corner of the site. Occasional debris or clear areas predominate the remainder of the site. Ground penetrating radar profiles were run at 4 representative locations to typify the various areas within the site. Ground penetrating radar field data is presented in Appendix D.

4.2.4.1.2 Site Hydrogeology

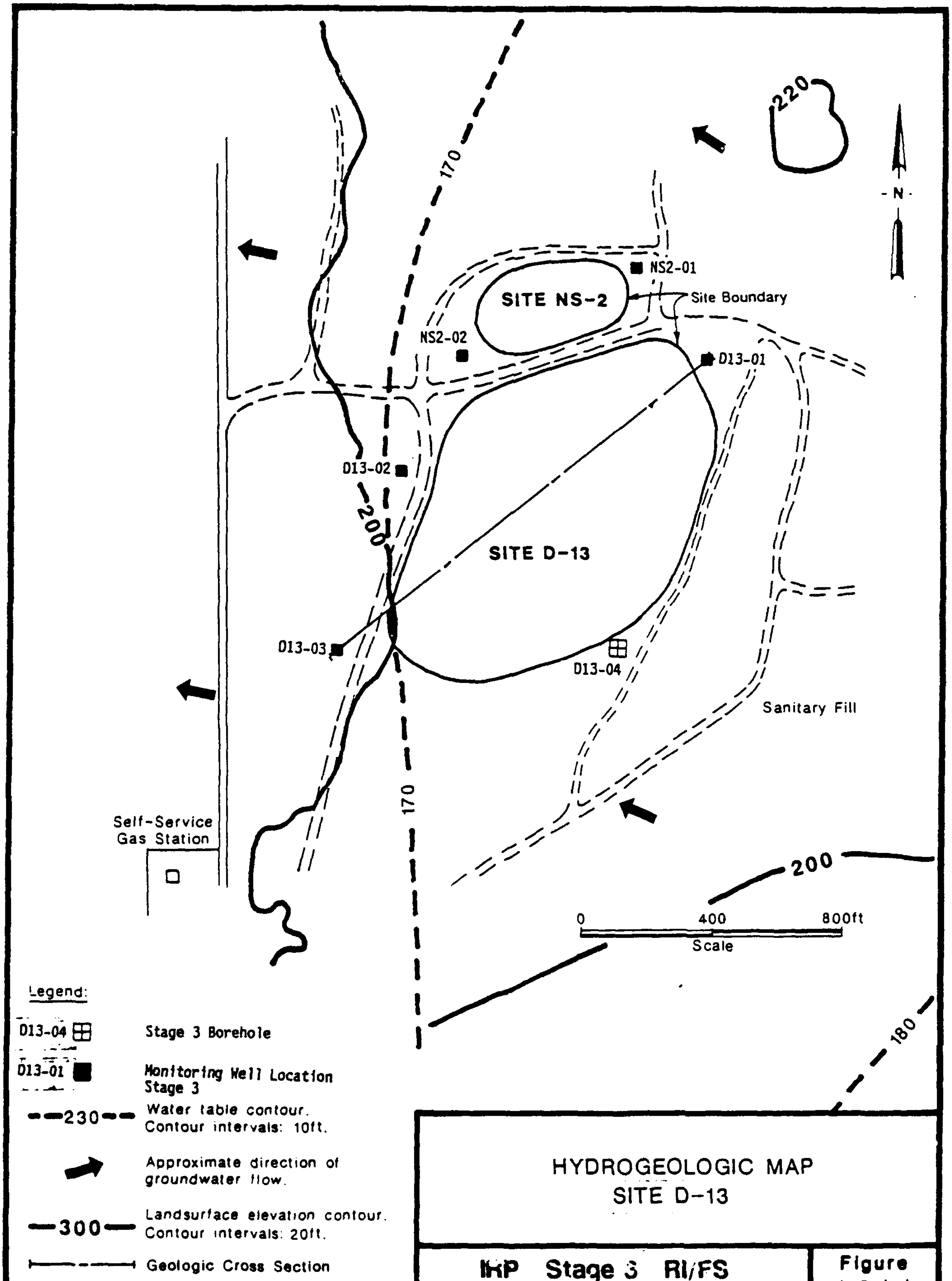
Site D-13 is underlain by coarse sands and gravels with some silt. The water table is at a depth of approximately 35 to 40 feet. The direction of groundwater flow is based on comparison of regional trends and water level measurements at 13 wells in the area. Groundwater contours are presented on Figure 4.2.4.4. The direction of groundwater flow is west-northwest with a gradient of approximately 20 feet per mile. The site is located less than 0.5 mile downgradient from Ship Creek, which loses water to the groundwater system in this area. Geologic deposits at this site are similar to deposits at the pump test site. Hydraulic conductivity values have not yet been estimated for this site.

4.2.4.1.3 Analytical Results

Field analytical results and observations and laboratory analytical results are discussed in the following sections.

4.2.4.1.3.1 Field Analytical Results and Observations

The presence of potential contamination at each boring was assessed in the field based on visual observations, odors or HNu readings. No indications of contamination were observed or recorded during field work at well D13-01.



HYDROGEOLOGIC MAP
SITE D-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.4.4

The following indications of contamination were noted at other boring locations:

Well D13-02 - HNu readings above background levels were recorded from soil samples at the following depths:

Soil Sample Depth	HNu Reading
1 foot	0.5 ppm
10 feet	10 ppm
15 feet	10 ppm
20 feet	3 ppm

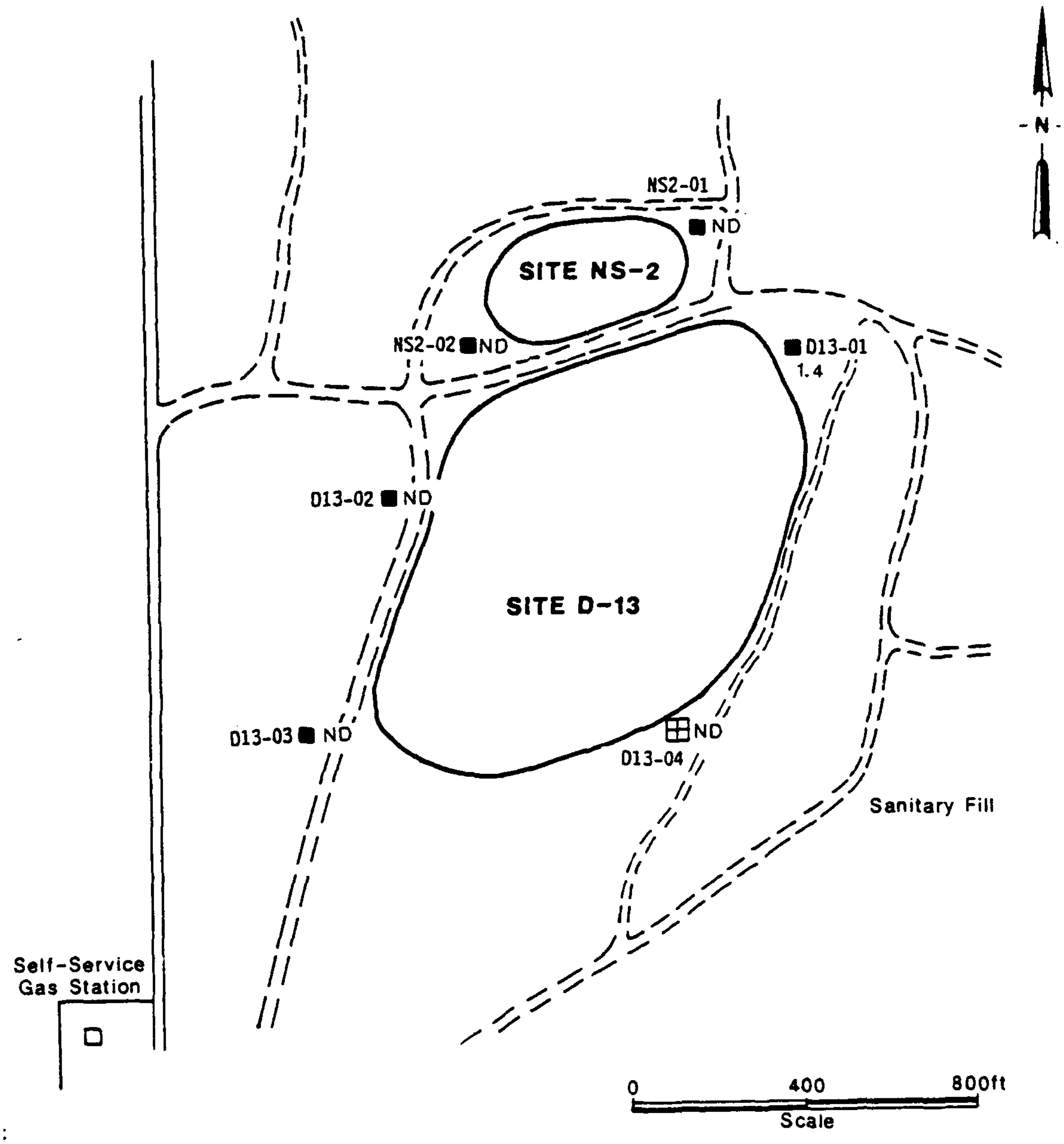
Well D13-03 - An HNu reading of 2 ppm was recorded from a soil sample taken at a depth of 22 feet.

Well D13-04 - HNu readings of 9 ppm or less were observed on soil samples taken at 5-foot intervals, to a depth of 60 feet (refer to boring log in Appendix C).

Field parameters measured at Site D-13 during groundwater sampling are presented in Table 4.2.4.1.

4.1.4.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site D-13 is presented in Table 4.2.4.2, and the sample plan for the base-wide field investigation program is included in Appendix B. Major organic contaminants identified from the laboratory analysis of samples collected at Site D-13 are plotted on Figures 4.2.4.5 through 4.2.4.10. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well or test boring. Sampling depth is included for the soil samples.



Legend:

D13-02 ■ Monitoring Well Location Stage 3

D13-04 ⊞ Stage 3 Borehole

Boring/Well Number

Boring/Well Location

Depth of Sample (ft)

Analyte Concentration

D13-02 (Symbol) 10/300

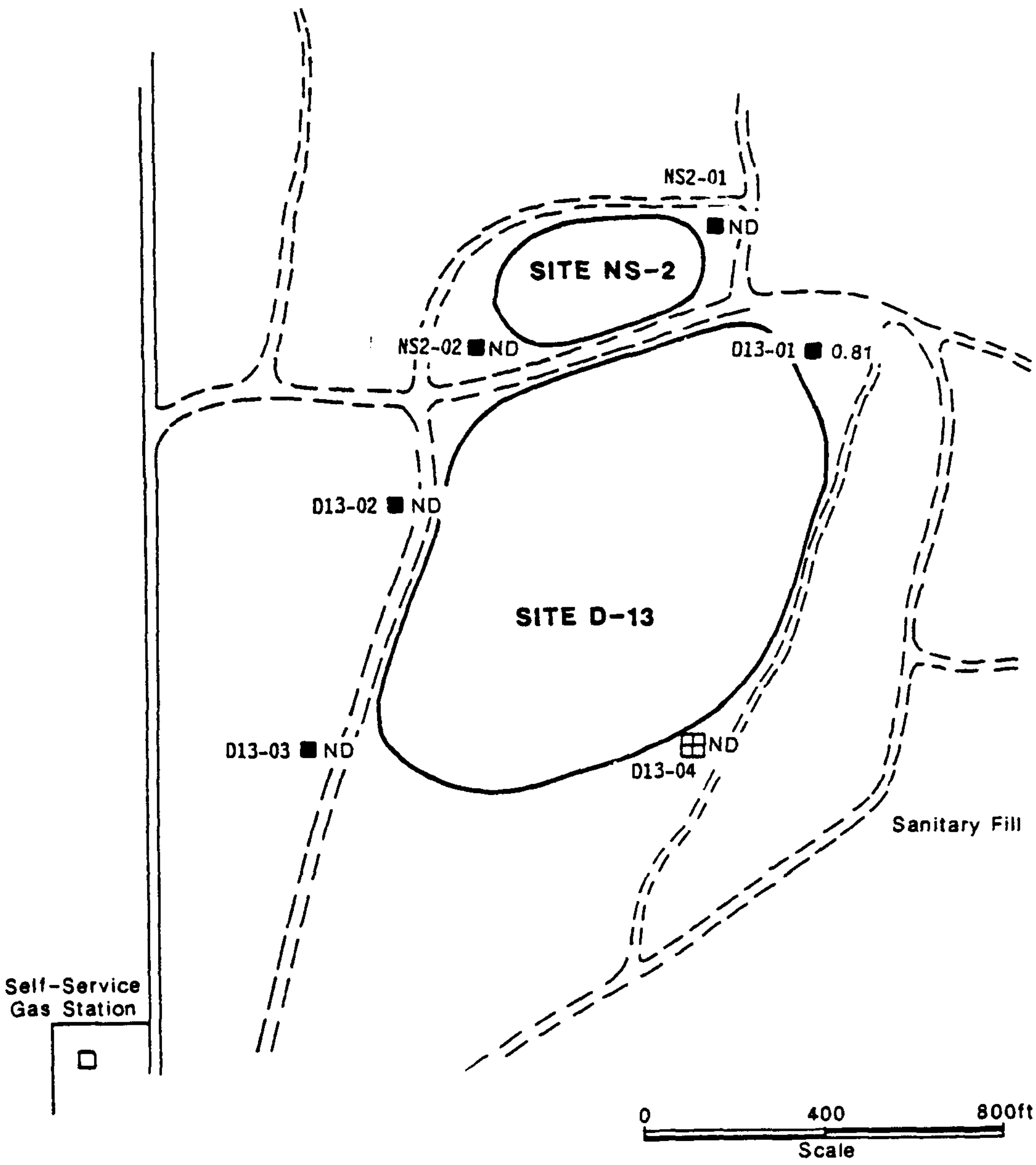
[Soil: mg/kg
Water: mg/L
ND Non-Detected]

Note: Water sample concentrations not associated with a depth.

TOTAL PETROLEUM HYDROCARBON CONCENTRATION
SITE D-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.4.5



Legend:

D13-03 ■ Monitoring Well Location Stage 3

D13-04 ⊞ Stage 3 Borehole

Boring/Well Number

Boring/Well Location

Depth of Sample (ft)

Analyte Concentration

D13-01 (Symbol) 10/300

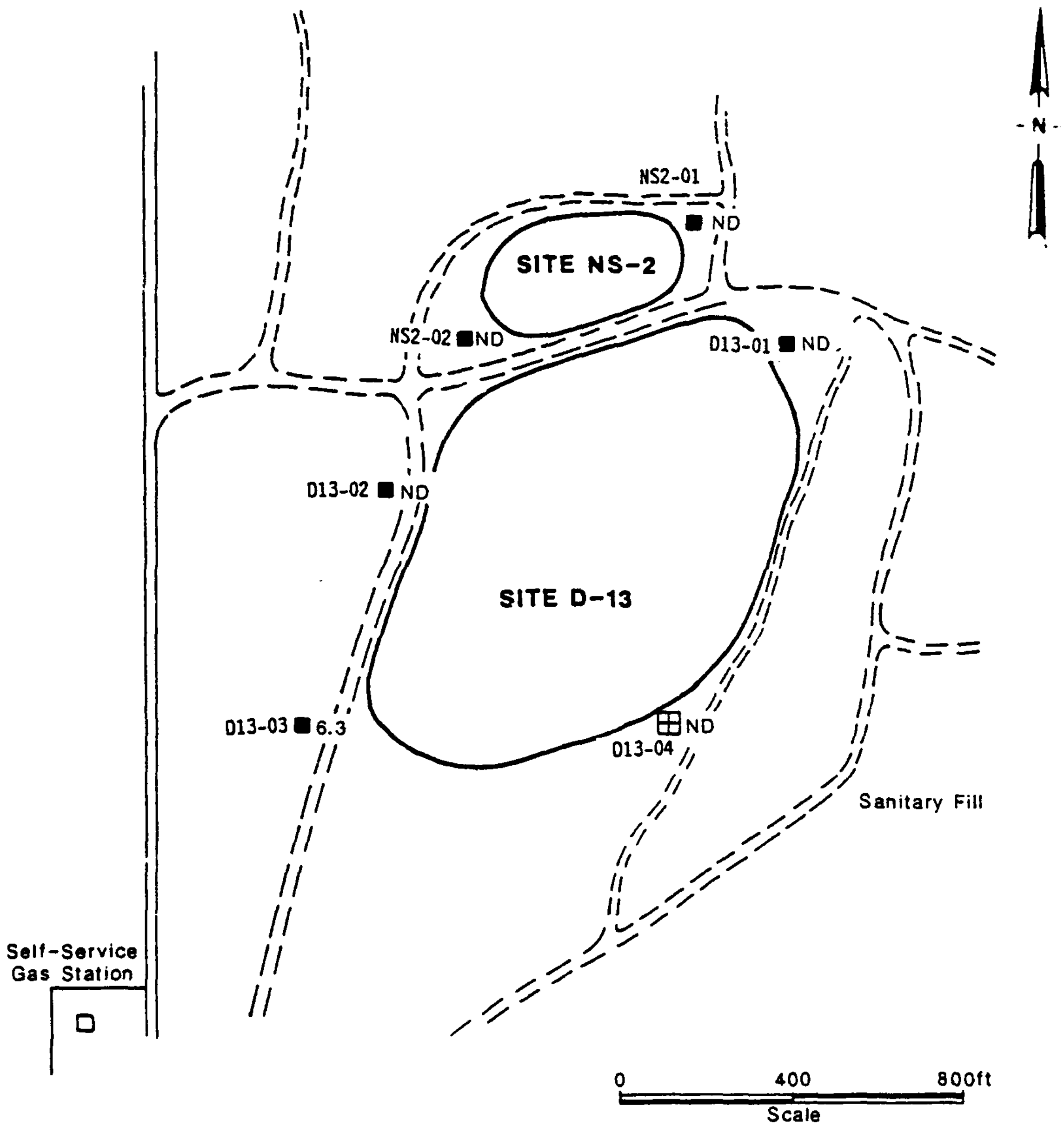
[Soil: mg/kg
Water: ug/L
ND: Non-Detected]

Note: Water sample concentrations not associated with a depth.

TRICHLOROETHENE
CONCENTRATION
SITE D-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.4.6



Legend:

D13-03 ■	Monitoring Well Location Stage 3
D13-04 ⊞	Stage 3 Borehole

Boring/Well Number

Boring/Well Location

Depth of Sample (ft)

Analyte Concentration

D13-01 (Symbol) 10/300

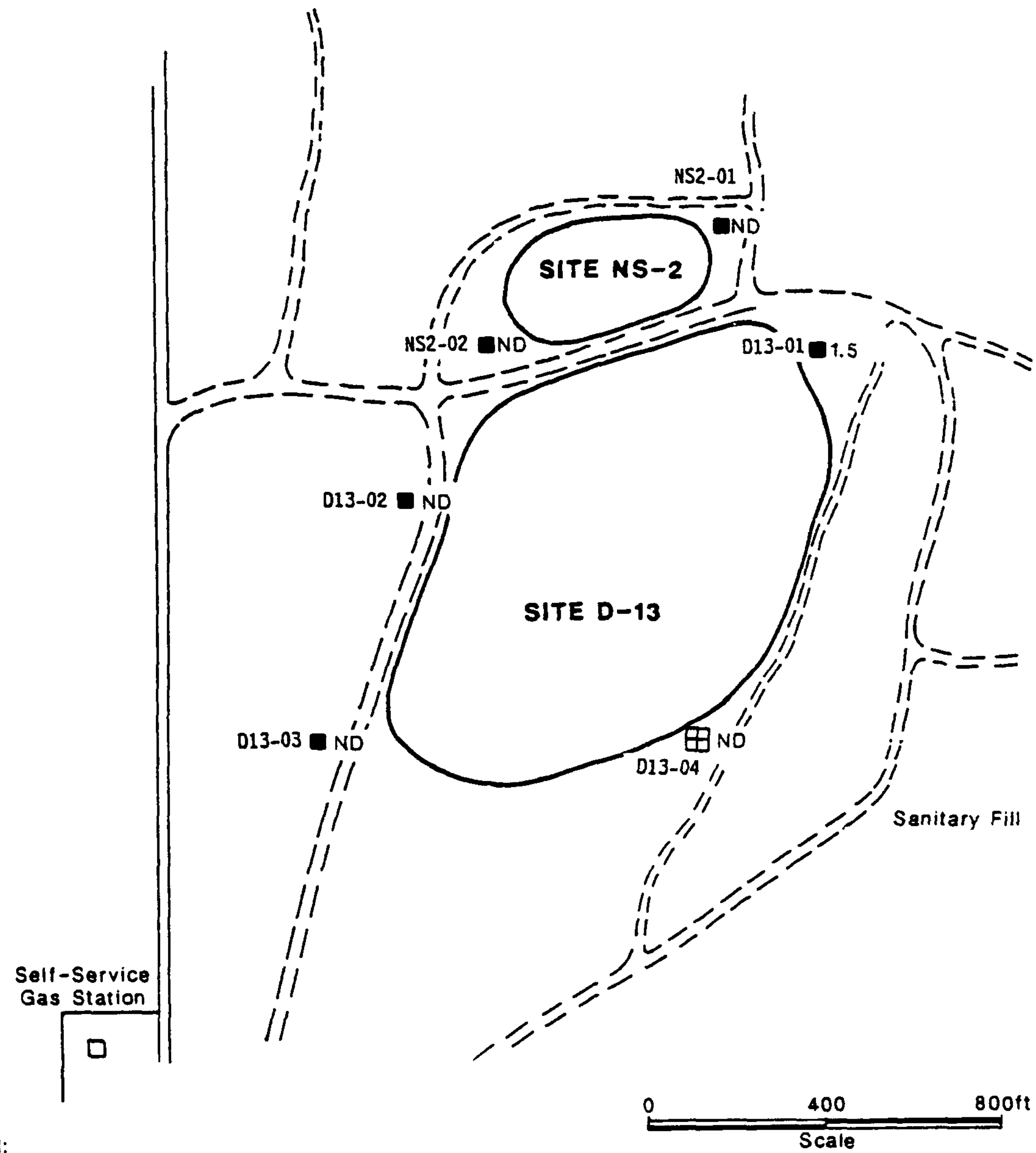
Soil: mg/kg
Water: µg/L
ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

1,1,1-TRICHLOROETHANE CONCENTRATION SITE D-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.4.7



Legend:

D13-02 ■ Monitoring Well Location Stage 3

D13-04 ⊞ Stage 3 Borehole

Boring/Well Number

Boring/Well Location

Depth of Sample (ft)

Analyte Concentration

D13-01 (Symbol) 10/300

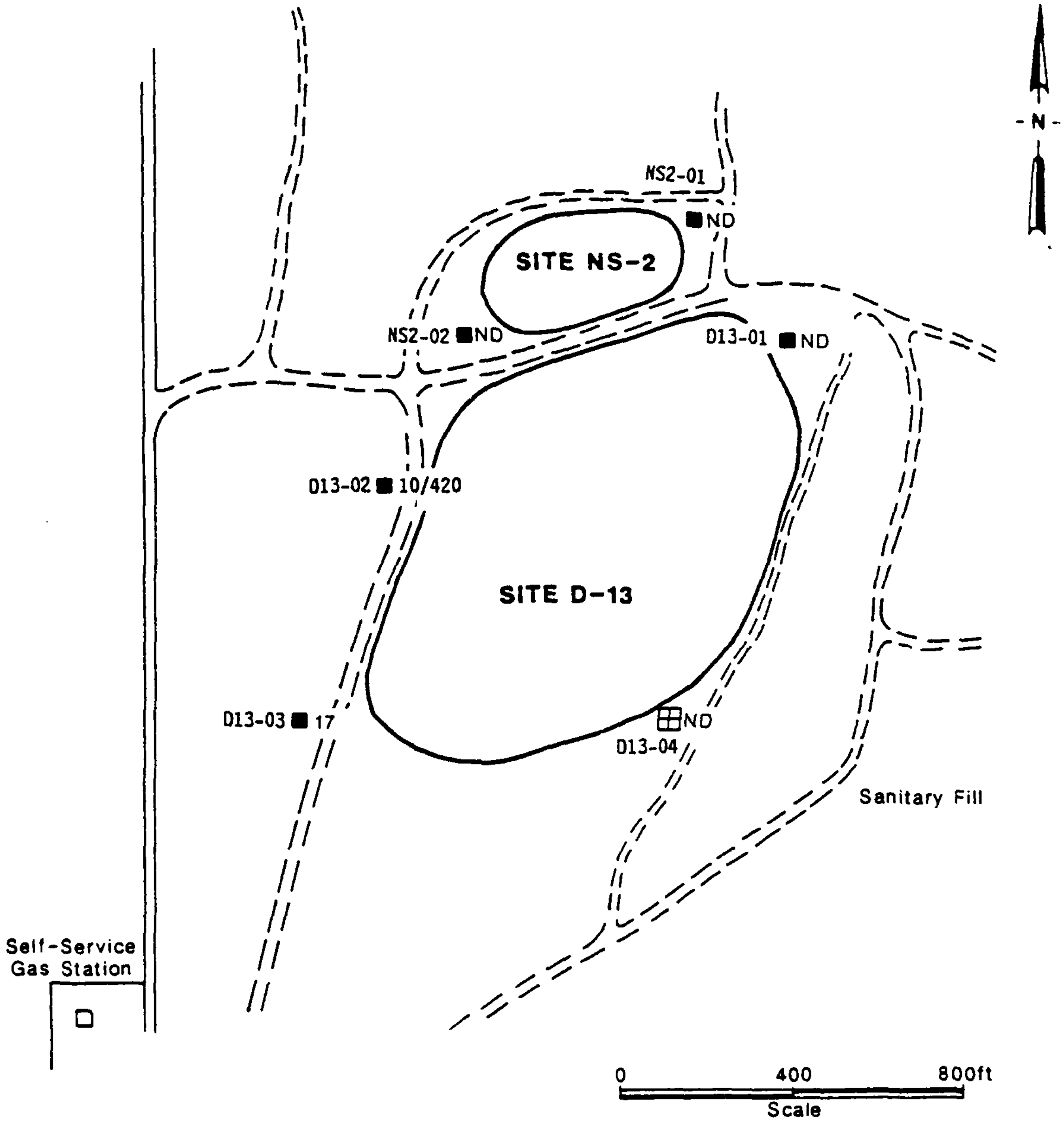
Soil: mg/kg
Water: µg/L
ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

TETRACHLOROETHENE
CONCENTRATION
SITE D-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.4.8



Legend:

D13-02 ■ Monitoring Well Location Stage 3

D13-04 ⊞ Stage 3 Borehole

Boring/Well Number
Boring/Well Location
Depth of Sample (ft)
Analyte Concentration
[Soil: mg/kg
Water: µg/L
ND: Non-Detected]

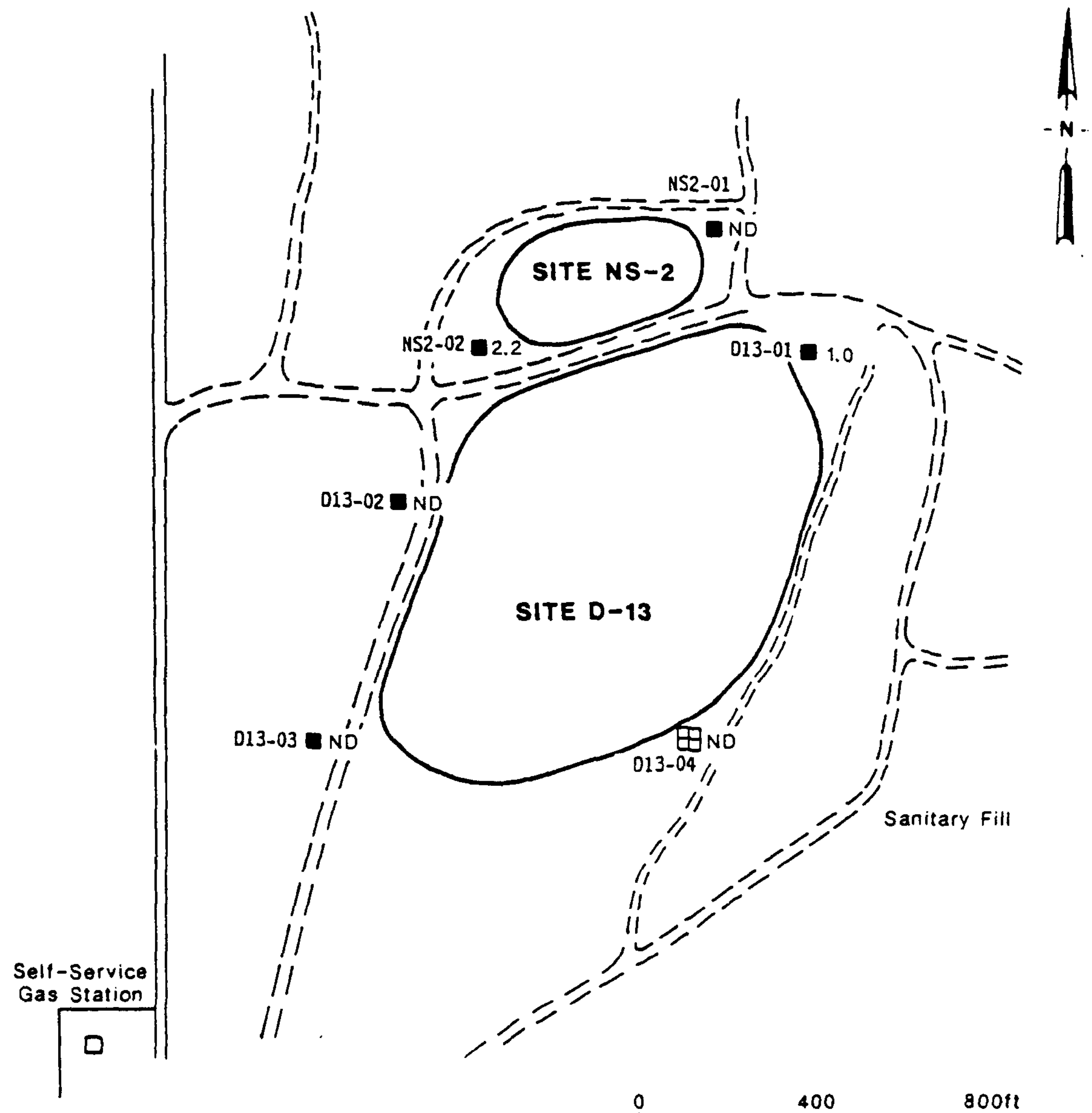
D13-02 (Symbol) 10/300

Note: Water sample concentrations not associated with a depth.

TRICHLOROFLUOROMETHANE
CONCENTRATION
SITE D-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.4.9



Legend:

D13-01 ■ Monitoring Well Location Stage 3

D13-04 ⊞ Stage 3 Porehole

Boring/Well Number

Boring/Well Location

Depth of Sample (ft)

Analyte Concentration

D13-04 (Symbol) 10/300

Soil: mg/kg
Water: µg/L
ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

VINYL CHLORIDE
CONCENTRATION
SITE D-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.4.10

Table 4.2.4.1 Field Parameters Site D-13

Well No. Appearance	Date Samples	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	
D13-01	8/09/88	6.0	197	6.37	70	No odor or sheen
D13-02	8/08/88	6.0	178	6.61	98	No odor or sheen
D13-03	8/08/88	6.0	132	6.92	17	No odor or sheen

Table 4.2.4.2 Requested Laboratory Analyses for Samples from Site D-13

SOIL

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
6010	ICP Screen (25 metals)
7471	Mercury
8240	Volatile Organic Compounds
8270	Semi-volatile Organic Compounds
160.3	Soil Moisture Content

WATER

Test Number	Analysis
300	Common Anions
418.1	Petroleum Hydrocarbons
200.7	ICP Screen (total and dissolved)
206.2	Arsenic (total and dissolved)
239.2	Lead (total and dissolved)
245.1	Mercury (total dissolved)
270.2	Selenium (total and dissolved)
601	Purgeable Halocarbons
602	Purgeable Aromatics
625	Extractable Priority Pollutants

Results of analytical tests are presented in Table 4.2.4.3.

4.2.4.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site D-13 are presented in Table 4.2.4.3.

4.2.4.1.5 Discussion of Analytical Data

Hydrocarbon compounds were prevalent at Site D-13. However, the concentrations were generally low and isolated to 1 or 2 borings (Figures 4.2.4.5 through 4.2.4.10). For example, vinyl chloride, tetrachloroethene, and trichloroethene were detected at concentrations of 1.0, 1.5, and 0.81 ug/L in water from well D13-01. Trichlorofluoromethane was found in a soil sample from well D13-02 at a concentration of 420 mg/kg. Water from well D13-03 also contained trichlorofluoromethane (17 ug/L) and 1,1,1-trichloroethane (6.3 ug/L). Total petroleum hydrocarbons were detected only in a water sample from well D13-01 at a concentration of 1.4 mg/L.

Metals such as aluminum (10600 to 15,300 mg/kg), iron (21,200 to 30,800 mg/kg), manganese (330 to 730 mg/kg) and magnesium (7700 to 11,100 mg/kg) were detected in soil samples from the site. The highest concentrations of these metals were detected in the soil sample taken from a depth of 10 feet from well D13-02. Water samples also contained these metals in total recoverable form at concentrations as high as 536 mg/L for aluminum, 1320 mg/kg for iron, 79 mg/L for manganese and 314 mg/L for magnesium, in water collected from well D13-03. Water samples from wells D13-01 and D13-02, located to the north, contained much lower total recoverable concentrations of these metals. Maximum detected dissolved concentrations were 4.5 mg/L for iron, 7.0 mg/L for magnesium, 0.0002 mg/L for mercury and 7.4 mg/L for manganese.

Table 4.2.4.3

Analytical Results - Site D-13

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	D13-01 RESAMPLE 0687-NG-015 GN-88-0002R 001229-0007	D13-01 0687-NG-015 GN-88-0003 001240-0009	D13-01 40'-41.5' 0687-SO-015 GS-88-0001 000798-0001	D13-01 50'-51.5' 0687-SO-015 GS-88-0002 000798-0002	D13-04 15'-16.5' 0687-SO-018 GS-88-0001 000827-0014	D13-04 40'-41.5' 0687-SO-018 GS-88-0002 000827-0015
1,1,1-Trichloroethane	EPA 601	ug/L	200						
Aluminum	6010	mg/kg				12220	11552	11777	11493
Barium	6010	mg/kg				38	30	31	32
Beryllium	6010	mg/kg				0.2	0.2	0.2	0.2
Calcium	6010	mg/kg				4596	4434	4069	4858
Chloride	300.0	mg/L	250		2.8				
Chromium	6010	mg/kg	50,000			27	25	22	21
Cobalt	6010	mg/kg				9	9	10	8
Copper	6010	mg/kg	1,850			21	18	21	20
Dissolved Aluminum	200.7	mg/L							
Dissolved Arsenic	206.2	mg/L	0.05						
Dissolved Barium	200.7	mg/L	1.0	0.016					
Dissolved Calcium	200.7	mg/L		29.					
Dissolved Chromium	200.7	mg/L	0.05						
Dissolved Cobalt	200.7	mg/L							
Dissolved Copper	200.7	mg/L	1.0						
Dissolved Iron	200.7	mg/L	0.3	2.6					
Dissolved Lead	239.2	mg/L	0.05						
Dissolved Magnesium	200.7	mg/L		5.8					
Dissolved Manganese	200.7	mg/L	0.05	1.3					
Dissolved Nickel	200.7	mg/L							
Dissolved Sodium	200.7	mg/L	250	3.7					
Dissolved Vanadium	200.7	mg/L							
Dissolved Zinc	200.7	mg/L	5.0	0.02					
Iron	6010	mg/kg				24776	22870	26017	25000
Lead	6010	mg/kg	70					6	
Magnesium	6010	mg/kg				8744	8751	8672	8294
Manganese	6010	mg/kg	11,000			460	385	514	486
Mercury	7471	mg/kg	100					0.20	
Nickel	6010	mg/kg	500			26	26	25	24
Potassium	6010	mg/kg							
Recoverable Aluminum	200.7	mg/L			21.				
Recoverable Arsenic	206.2	mg/L	0.05		0.012				
Recoverable Barium	200.7	mg/L	1.0		0.25				
Recoverable Beryllium	200.7	mg/L	0.0000039						
Recoverable Calcium	200.7	mg/L			56.				
Recoverable Chromium	200.7	mg/L	0.05		0.04				
Recoverable Cobalt	200.7	mg/L			0.03				
Recoverable Copper	200.7	mg/L	1.0		0.21				
Recoverable Iron	200.7	mg/L	0.3		60.				
Recoverable Lead	239.2	mg/L	0.05		0.029				
Recoverable Magnesium	200.7	mg/L			20.				
Recoverable Manganese	200.7	mg/L	0.05		8.5				
Recoverable Nickel	200.7	mg/L			0.11				
Recoverable Sodium	200.7	mg/L	250		9.3				
Recoverable Vanadium	200.7	mg/L			0.09				
Recoverable Zinc	200.7	mg/L	5.0		0.10				
Sodium	6010	mg/kg				123	128	86	95
Sulfate	300.0	mg/L	250		13.				
Tetrachloroethene	EPA 601	ug/L	5.0		1.5				
Total Mercury	245.1	mg/L	0.002		0.0006				
Total Petroleum Hydrocarbons	EPA 418.1				1.4				
Total Solids	160.3	%	500			89.2	85.7	93.4	84.4
Trichloroethene	EPA 601	ug/L	5.0						
Trichlorofluoromethane	EPA 601	ug/L			0.81				
Vanadium	6010	mg/kg	1,000			45	42	44	46
Vinyl chloride	EPA 601	ug/L	2.0						
Zinc	6010	mg/kg	10,500		1.0	52	46	46	45

Table 4.2.4.3

Analytical Results - Site D-13

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	D13-02 0687-NS-016 GN-88-0003 001167-0003	D13-02 RESAMPLE 0687-NG-016-GN-880003R 001268-0003	D13-02 10'-11.5' 0687-SO-016 GS-88-0001 000798-0004	D13-02 39'-40.5' 0687-SO-016 GS-88-0002 000798-0005	D13-03 0687-NS-017 GN-88-0003 001167-0007	D13-03 RESAMPLE 0687-NG-017 GN-88-0003R 001324-0008
1,1,1-Trichloroethane	EPA 601	ug/L	200					6.3	
Aluminum	6010	mg/kg				15344	10579		
Barium	6010	mg/kg				60	31		
Beryllium	6010	mg/kg				0.3	0.2		
Calcium	6010	mg/kg				5079	4677		
Chloride	300.0	mg/L	250	8.5				4.0	
Chromium	6010	mg/kg	50,000			29	21		
Cobalt	6010	mg/kg				13	9		
Copper	6010	mg/kg	1,850			25	19		
Dissolved Aluminum	200.7	mg/L							0.17
Dissolved Arsenic	206.2	mg/L	0.05	0.010					
Dissolved Barium	200.7	mg/L	1.0		0.021				0.15
Dissolved Calcium	200.7	mg/L			33.				27.
Dissolved Chromium	200.7	mg/L	0.05						
Dissolved Cobalt	200.7	mg/L			0.02				
Dissolved Copper	200.7	mg/L	1.0						
Dissolved Iron	200.7	mg/L	0.3		4.5				0.33
Dissolved Lead	239.2	mg/L	0.05	0.020				0.020	
Dissolved Magnesium	200.7	mg/L			7.0				5.1
Dissolved Manganese	200.7	mg/L	0.05		7.4				0.052
Dissolved Nickel	200.7	mg/L			0.02				
Dissolved Sodium	200.7	mg/L	250		6.3				22.
Dissolved Vanadium	200.7	mg/L							
Dissolved Zinc	200.7	mg/L	5.0						0.04
Iron	6010	mg/kg				30794	21158		
Lead	6010	mg/kg	70			7			
Magnesium	6010	mg/kg				11111	7684		
Manganese	6010	mg/kg	11,000			772	457		
Mercury	7471	mg/kg	100			0.13	0.10		
Nickel	6010	mg/kg	500			37	22		
Potassium	6010	mg/kg				952			
Recoverable Aluminum	200.7	mg/L		25.				536.	
Recoverable Arsenic	206.2	mg/L	0.05	0.010				0.010	
Recoverable Barium	200.7	mg/L	1.0	0.26				6.4	
Recoverable Beryllium	200.7	mg/L	0.0000039					0.020	
Recoverable Calcium	200.7	mg/L		37.				350.	
Recoverable Chromium	200.7	mg/L	0.05	0.04				1.3	
Recoverable Cobalt	200.7	mg/L		0.06				1.3	
Recoverable Copper	200.7	mg/L	1.0	0.24				5.5	
Recoverable Iron	200.7	mg/L	0.3	64.				1320.	
Recoverable Lead	239.2	mg/L	0.05	0.031				0.062	
Recoverable Magnesium	200.7	mg/L		18.				314.	
Recoverable Manganese	200.7	mg/L	0.05	8.6				79.	
Recoverable Nickel	200.7	mg/L		0.14				3.3	
Recoverable Sodium	200.7	mg/L	250	6.3				8.4	
Recoverable Vanadium	200.7	mg/L		0.09				1.9	
Recoverable Zinc	200.7	mg/L	5.0	0.15				3.1	
Sodium	6010	mg/kg				169	111		
Sulfate	300.0	mg/L	250	18.				14.	
Tetrachloroethene	EPA 601	ug/L	5.0						
Total Mercury	245.1	mg/L	0.002					0.017	0.0002
Total Petroleum Hydrocarbons	EPA 418.1							0.017	
Total Solids	160.3	%	500			94.5	89.8		
Trichloroethene	EPA 601	ug/L	5.0			92.0			
Trichlorofluoromethane	EPA 601	ug/L							
Vanadium	6010	mg/kg	1,000			423	38	17.	
Vinyl chloride	EPA 601	ug/L	2.0			56			
Zinc	6010	mg/kg	10,500				40		

Table 4.2.4.3

Analytical Results - Site D-13

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	D13-03 35'-36.5' 0687-SO-017 GS-88-0001 000827-0004	D13-03 45'-46.5' 0687-SO-017 GS-88-0002 000827-0005
1,1,1-Trichloroethane	EPA 601	ug/L	200		
Aluminum	6010	mg/kg		10428	12024
Barium	6010	mg/kg		32	44
Beryllium	6010	mg/kg		0.2	0.2
Calcium	6010	mg/kg		3842	4762
Chloride	300.0	mg/L	250		
Chromium	6010	mg/kg	50,000	24	24
Cobalt	6010	mg/kg		8	10
Copper	6010	mg/kg	1,850	29	23
Dissolved Aluminum	200.7	mg/L			
Dissolved Arsenic	206.2	mg/L	0.05		
Dissolved Barium	200.7	mg/L	1.0		
Dissolved Calcium	200.7	mg/L			
Dissolved Chromium	200.7	mg/L	0.05		
Dissolved Cobalt	200.7	mg/L			
Dissolved Copper	200.7	mg/L	1.0		
Dissolved Iron	200.7	mg/L	0.3		
Dissolved Lead	239.2	mg/L	0.05		
Dissolved Magnesium	200.7	mg/L			
Dissolved Manganese	200.7	mg/L	0.05		
Dissolved Nickel	200.7	mg/L			
Dissolved Sodium	200.7	mg/L	250		
Dissolved Vanadium	200.7	mg/L			
Dissolved Zinc	200.7	mg/L	5.0		
Iron	6010	mg/kg		21515	23929
Lead	6010	mg/kg	70		
Magnesium	6010	mg/kg		9001	8929
Manganese	6010	mg/kg	11,000	494	512
Mercury	7471	mg/kg	100	0.09	0.06
Nickel	6010	mg/kg	500	25	26
Potassium	6010	mg/kg			
Recoverable Aluminum	200.7	mg/L			
Recoverable Arsenic	206.2	mg/L	0.05		
Recoverable Barium	200.7	mg/L	1.0		
Recoverable Beryllium	200.7	mg/L	0.0000039		
Recoverable Calcium	200.7	mg/L			
Recoverable Chromium	200.7	mg/L	0.05		
Recoverable Cobalt	200.7	mg/L			
Recoverable Copper	200.7	mg/L	1.0		
Recoverable Iron	200.7	mg/L	0.3		
Recoverable Lead	239.2	mg/L	0.05		
Recoverable Magnesium	200.7	mg/L			
Recoverable Manganese	200.7	mg/L	0.05		
Recoverable Nickel	200.7	mg/L			
Recoverable Sodium	200.7	mg/L	250		
Recoverable Vanadium	200.7	mg/L			
Recoverable Zinc	200.7	mg/L	5.0		
Sodium	6010	mg/kg		66	119
Sulfate	300.0	mg/L	250		
Tetrachloroethene	EPA 601	ug/L	5.0		
Total Mercury	245.1	mg/L	0.002		
Total Petroleum Hydrocarbons	EPA 418.1				
Total Solids	160.3	%	500	91.1	84.0
Trichloroethene	EPA 601	ug/L	5.0		
Trichlorofluoromethane	EPA 601	ug/L			
Vanadium	6010	mg/kg	1,000	37	44
Vinyl chloride	EPA 601	ug/L	2.0		
Zinc	6010	mg/kg	10,500	43	45

Calcium levels in soil samples (3800 to 5100 mg/kg) and water samples (total: 37 to 350 mg/L, dissolved: 27 to 33 mg/L), sodium levels in soil samples (44 to 170 mg/kg) and water samples (total: 6.3 to 9.3 mg/L, dissolved: 3.7 to 22 mg/L), and potassium levels in soil samples (950 mg/kg) are due to the natural mineral content of the surrounding soils. Potassium was detected only in soil from well D13-02, and the highest concentration of calcium in a water sample (350 mg/L) was detected in well D13-03.

Sulfate and chloride ions were detected in water samples from all wells at concentrations ranging from 13 mg/L to 18 mg/L and 2.8 mg/L to 8.5 mg/L, respectively.

Concentrations of less than 70 mg/kg of other elements such as barium, chromium, copper, nickel, vanadium and zinc were detected in soil samples from all borings. Total recoverable cobalt was detected at concentrations less than 15 mg/kg in all soil samples, and at concentrations less than 1.5 mg/L in all water samples. Water samples from wells D13-01 and D13-03 contained only total barium, copper, and zinc at total concentrations less than 7.0 mg/L and dissolved barium and zinc at concentrations less than 0.2 mg/L. A water sample from well D13-02 contained all of the above elements at total recoverable levels ranging from 0.04 mg/L for chromium to 0.26 mg/L for barium.

Trace amounts of beryllium (less than 0.5 mg/kg) were detected in soil samples from all wells at Site D-13 and boring D13-04. However, this element was only detected in its total recoverable form in water from well D13-03 (0.02 mg/L). Mercury was detected in soil samples from wells D13-02, D13-03, and boring D13-04 at total concentrations ranging from 0.06 to 0.20 mg/kg, and in water samples from wells D13-01 (0.0006 mg/L) and D13-03 (0.017 mg/L). Soil samples from well D13-02 and boring D13-04 contained lead at 7.4 mg/kg and 6.4 mg/kg, respectively. Water samples from all 3 contained trace amounts of total lead (less than 0.1 mg/L) and arsenic (less than 0.01 mg/L).

4.2.4.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site D-13 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the workplan.

4.2.4.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis were lost from Site D-13.

4.2.4.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in samples from the site.

4.2.4.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Eight soil samples were collected from 4 borings drilled at the site. Three boreholes were completed as monitoring wells and 1 water sample was obtained from each well. However, water samples to be tested for dissolved metals were not originally filtered in the field. This was corrected by resampling the wells for dissolved metals only, and filtering the samples onsite prior to shipment. Valid dissolved metals data has field sample numbers followed by an R as indicated in Table 4.2.4.3.

4.2.4.2.4 Corrective Actions Applied to Out-of-Control Events, Including a Chronology of Rerunning Samples and Controls

The 3 wells at Site D-13 were resampled for dissolved metals. The following table shows when sampling and resampling activities were conducted.

Well Number	Original Sampling Date	Resampling Date
D13-01	8/9/88	8/13/88
D13-02	8/8/88	8/15/88
D13-03	8/8/88	8/19/88

4.2.4.3 Significance of Findings for Site D-13

Analytical results for water samples from Site D-13 indicated contamination by various organic compounds. Trichlorofluoromethane (Freon-11), *tetrachloroethene*, vinyl chloride, and 1,1,1-trichloroethane were detected in water samples from the site but all were below groundwater cleanup levels.

Total recoverable concentrations of barium, beryllium, chromium, copper, iron, lead, manganese, and mercury in groundwater were above groundwater cleanup levels; however, the dissolved levels for all the above metals except iron and mangenese were much less. The high total recoverable metals concentrations are due to a soil phenomenon, as discussed in Section 4.1.2.

The concentrations of iron and manganese are above cleanup levels. Iron falls outside the background wells range, but is known to occur at high concentrations in the Elmendorf area (Glass, USGS, personal communication, 05 July 1989 and Putnam, Municipality of Anchorage, personal communication, 06 July 1989). Manganese falls far outside the background concentration range at well D3-02. Both metals were

detected in the soils at concentrations similar to background. However, it is possible that steel and iron debris buried in the landfill may be contributing to the iron concentrations in the groundwater. The concentrations of other metals are at expected background levels.

4.2.4.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. The water samples from well D13-01 contained the highest concentrations of TPH, trichloroethene, and well D13-03 contained the highest concentrations of Freon-11 and 1,1,1-trichloroethane.

4.2.4.3.2 Contaminant Migration

The primary migration medium at Site D-13 is groundwater. Freon-11, detected in well D13-03 was also detected in several wells sampled for Site D-7 (see Section 4.2.3.3). Site D-7 is located within the boundaries of Site D-13. Freon-11 was detected in wells GW-1B and GW-2B at Site D-7, both of which are generally downgradient of well D13-03.

4.2.4.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off-Base migration is unknown. Wells D13-02 and D13-03 are outside and downgradient of the landfill boundary. Well D13-03 was found to be contaminated with Freon-11. Two other wells, wells GW-1B and GW-2B at Site D-7 (Section 4.2.3) both lie within the landfill boundaries immediately to the east of wells D13-02 and D13-03. Wells GW-1B and GW-2B at Site D-7 were also contaminated with Freon-11.

4.2.4.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site identified the direction of groundwater flow to be to the west-northwest, with a gradient of about 20 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of migration rate of the dissolved chemicals.

4.2.4.3.2.3 Time of Travel to Receptors

Primary receptors are humans, plants, and wildlife. The primary pathway to the receptors is through contaminated groundwater. A downgradient active well (Base Well 42) is located about 5200 feet from Site D-13 at Building 11-200. Hydraulic conductivity has not been estimated for this groundwater; thus, time of travel cannot be estimated for this well. Base Well 42 is an artesian well, drilled to a depth of 225 feet (Phase II, Stage 2 Report, Dames and Moore, 1987). The water from Base Well 42 is contained inside a casing as it flows through the zones of potential contamination detected at Site D-13, and is unlikely to be affected by the site. The wells sampled at Site D-13 are 56 feet deep or less. A gravel pit less than 500 feet north of the site has the potential to expose groundwater during gravel-removal operations. Although the pit is generally upgradient of the landfill boundaries, seasonal and/or temporal factors may allow contamination migration in that direction, or expansion of the pit may extend into areas downgradient of the landfill boundaries. Time of travel to an expanded gravel pit would be negligible.

4.2.4.3.2.4 Applicability of Solute Transport Models

The applicability of solute transport models at Site D-13 cannot be determined by this study due to the need for more information from downgradient wells. Wells installed to the north and northwest of the site and additional hydrogeological data would provide useful information and more accurate solute transport models. The results from the modeling would help to determine the potential risk of contamination for downgradient water supplies and surface water.

4.2.4.3.2.5 Expected Spatial and Temporal Variations in Concentration

Groundwater flow is primarily to the west-northwest at Site D-13. The spacial extent of contamination past the site boundaries is evidenced by contamination in wells D13-02 and D13-03, which are about 100 feet from what is estimated to be the landfill boundary. The contamination may or may not extend farther to the northwest.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of the metals is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.4.3.3 Baseline Risk Assessment

The contamination present in relation to exposure pathways, receptors, and expected health effects are characterized in the following sections.

4.2.4.3.3.1 Waste Characterization

The primary wastes at this site are trichlorofluoromethane (Freon-11), tetrachloroethene, and vinyl chloride. Freon-11 is used as an aerosol

propellant and as a refrigerant; it is a suspected human carcinogen. Tetrachloroethene is used as a solvent for oils and paints and is a known animal carcinogen. Vinyl chloride is used in the production of vinyl chloride resins, methyl chloroform and as a component of propellant mixtures.

Reports indicate that vinyl chloride is an anaerobic decomposition product of other chlorinated "ethenes". For example, tetrachloroethene, trichloroethene, and 1,1-dichloroethene are anaerobically dehalogenated to form vinyl cloride. Evidence suggests that these decomposition reactions occur fairly rapidly.

Iron and manganese are common metals found in steel and other scrap metals possibly buried in the landfill.

4.2.4.3.3.2 Source and Release Characterization

The source of contamination at Site D-13 is probably from landfilled materials. Organic compounds were introduced to the site from the burial of shop wastes and unknown wastes containerized in drums.

4.2.4.3.3.3 Fate and Transport of Contaminants

The fate of chemicals released to the environment at Site D-13 includes natural degradation, dispersion of the contaminants in the groundwater and/or uptake by living organisms. Since the vapor pressure of tetrachloroethene is greater than 1 mm of Hg (15.8 mm at 22^{o} C), volatilization is another possible fate for this compound. The fate of metals in the environment includes oxidation and/or chelation with organics, water or cations such as Cl- and OH-.

Transport of contaminants may have occured by leaching into the water from debris and wastes buried at Site D-13. Metal anions may then have become adsorbed onto soil particles, remaining bound until

conditions (pH and temperature) allow the anions to dissolve into interstitial water, which eventually percolates to the groundwater saturation zone. Any dissolved organic compounds from shop wastes would also percolate downward. At the water table, contaminants that are not soluable in water would migrate along the hydrogeological gradient. Dissolved contaminants would travel in groundwater through the process of advection.

Evidence for contaminant migration is not apparent at the site, although the 1 well that is offsite was contaminated with several organic compounds and metals that were found in wells within the assumed landfill boundary. The rate of groundwater flow, plume dimensions, and the precise direction of contamination migration are not known for this site.

The drinking water well at building 11-200 (base well 42) was last tested for volatile organics and metals in 1987. No volatile organics were detected in the sample, and all metals were detected at levels less than State of Alaska and EPA water quality standards. It appears that either contamination from Site D-13 has not reached this well, or the well design have prevented the contamination.

4.2.4.3.3.4 Exposure Pathways

The primary pathways of exposure are ingestion of or contact with contaminated groundwater, plants or wildlife.

4.2.4.3.3.5 Identification of Receptors

Human receptors include anyone drinking from the active well in the area (base well 42) should it become contaminated.

Humans and wildlife may be exposed through the ingestion of any contaminated water that may be exposed during gravel pit operations adjacent to the site.

4.2.4.3.3.6 Threat to Human Health

The most significant threat to human health is the drinking of water from base well 42, should contamination be detected in this well.

4.2.4.3.3.7 Carcinogenic Risks

Several compounds are suspected human carcinogens or known animal carcinogens were detected in water samples from Site D-13. Vinyl chloride is a known human carcinogen (Group A) and trichloroethene and tetrachloroethene are probable human carcinogens (Group B2).

4.1.4.3.3.8 Threat to Wildlife

The primary area where wildlife could be exposed to contamination is at the gravel pit about 500 feet north of the site. However, the quantity of groundwater which may be exposed by continued gravel pit excavations has not been determined and is expected to change seasonally. It is also not known if any exposed water would be contaminated by sources delineated at Site D-13. The threat to wildlife from contamination at the site is assessed as low.

4.2.4.4 Prioritization of Sites for Remedial Alternatives

Site D-13 is assigned a high priority for futher investigation due to the evidence of offsite migration and the sites probable relationship with Sites D-5, D-7 and NS-2. Further investigation is required prior to evaluation of remedial measures. It is recommended that Sites D-5,

D-7, D-13 and NS-2 be combined due to their proximity and the similarity of the contaminants found at these sites. This new site would be assigned a high priority for remedial alternatives due to contaminant levels exceeding State of Alaska water quality regulations and the evidence of offsite migration. Recommendations for further investigation at the combined sites are described under results for Site NS-2, DRMO Scrap Pile, in Section 4.2.21.4.

4.2.5 Discussion of Results for Site D-15, POL Sludge Disposal Site No. 1

Site D-15 (Figure 4.2.5.1) consists of a 1-acre area that was used from 1964 to 1968 to dispose of POL tank sludge (Engineering-Science, 1983). The area was also used to weather fuel filters and pads. The site was closed with local soil cover. The original area of investigation of Site D-15 was expanded across the road to the north about 100 feet based on a review of 1965 and 1973 aerial photographs and conversations with U.S. Air Force liquid fuels maintenance (LFM) personnel who recalled that oil filters and other liquid petroleum wastes were buried there over 15 years ago (personal communication, Russ Quinn, LFM superintendent, August 1988).

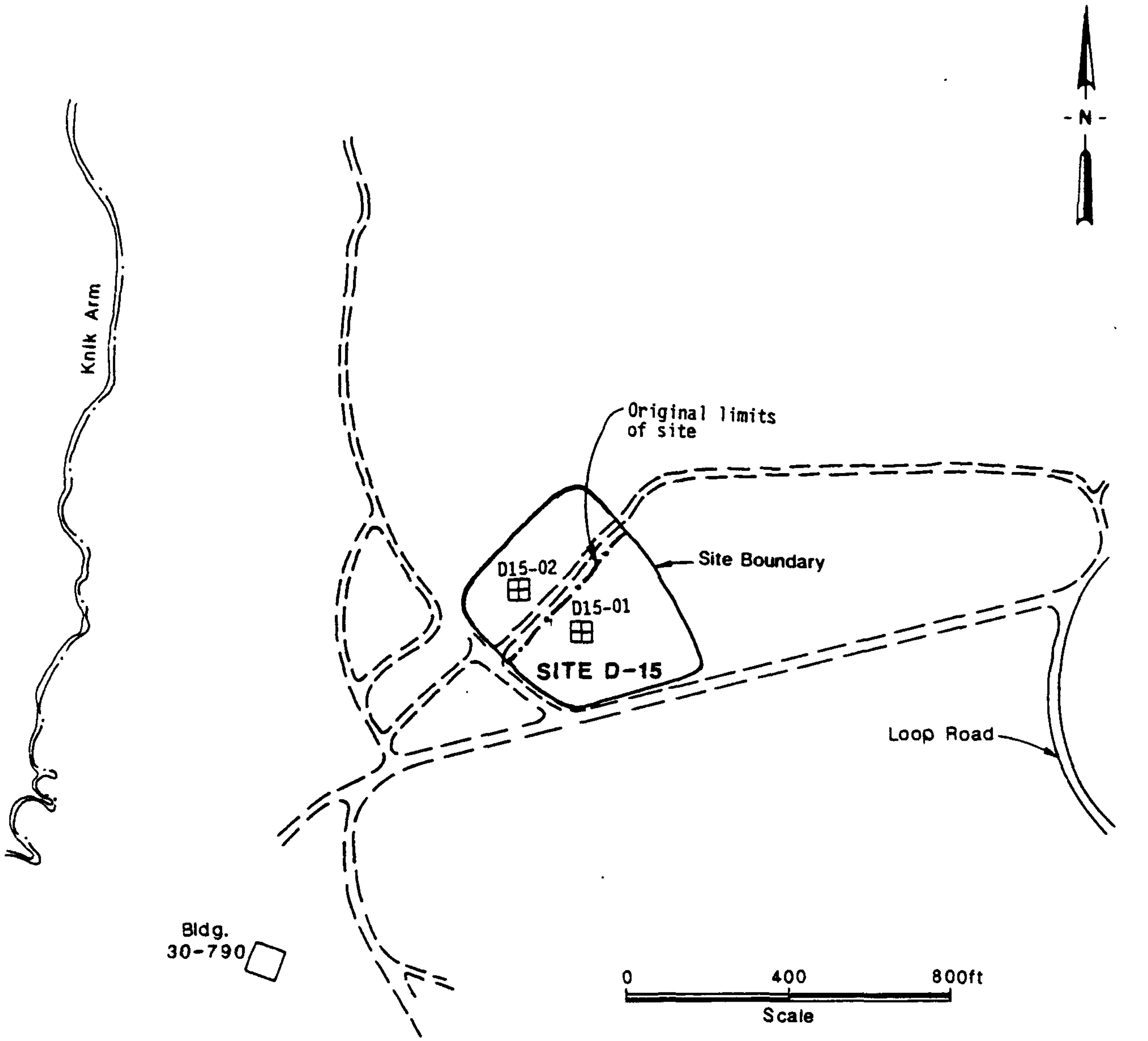
4.2.5.1 Presentation of Results for Site D-15

Results of the geologic and hydrogeologic investigations are presented below. Analytical results are tabulated and presented on the site maps.

4.2.5.1.1 Site Geology

The D-15 site is located at an elevation of about 200 feet near the Knik Arm bluff on late-Quaternary silty sand and gravel alluvial soils. The surficial alluvium overlies clayey layers of the Bootlegger Cove Formation at shallow depth. The site slopes slightly to the west and surface drainage is directly into Knik Arm.

The surface of the site has been altered by construction activities, and is currently covered by dense alders to a height of 20 feet. Some of the surface appears to have been bulldozed into ridges to a height of 5 to 10 feet. Scattered metallic debris, such as heavy equipment parts are evident on the southern portion of the site.



Legend:

D15-02 ⊞ Stage 3 Borehole

LOCATION MAP
SITE D-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.5.1

4.2.5.1.1.2 Geophysical Survey

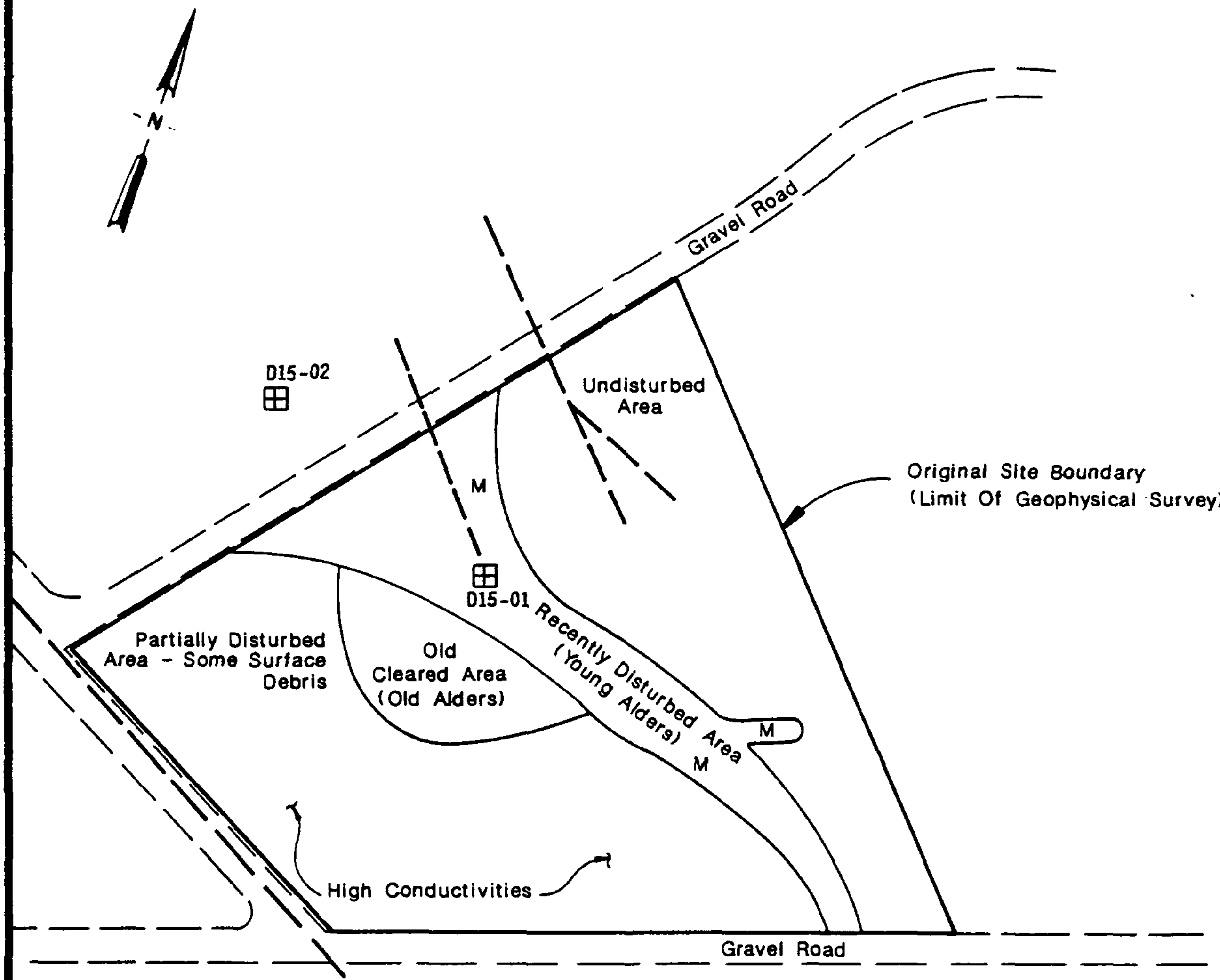
Results of a terrain conductivity geophysical survey conducted at Site D-15 using a Geonics EM-31 are presented on Figure 4.2.5.2. Interpretation of the survey results indicate the presence of metallic materials in the disturbed area through the center of the site and high conductivities in the southwest corner of the site. The density of vegetation severely limited a ground penetrating radar survey of the site although pipelines were located running parallel to the gravel roads adjacent to the original site boundary to the north and south.

4.2.5.1.1.3 Shallow Soil Borings

Two hand-dug test borings, each to a depth of 5 feet, were excavated at the site. Boring D15-01 was located in a highly disturbed area of the original site. Boring D15-02 was located in a zone to the north of the original site where dumping of POL wastes occurred about 15 years ago. Logs of the borings are presented in Appendix C. A geologic cross section of the site is presented in Figure 4.2.5.3.

4.2.5.1.2 Site Hydrogeology

Site D-15 is underlain by silt, sand and gravel at shallow (less than 5 feet) depths. Till and Bootlegger Cove Formation deposits occur at greater depths. Based on regional trends, groundwater flows toward the southwest through the site with a gradient of approximately 50 feet per mile (Figure 4.2.5.4). Water table contour information in Figure 4.2.5.4 was obtained from surface topography and a regional gradient map. Hydraulic conductivities at the site could be widely variable as a result of the heterogeneity of deposits in the area.



Note:

1. Average conductivity throughout area generally ranges from .75 to 85 mmho/m but are higher (.9mmho/m) in the southwest corner.

2: M = metallic materials (i.e. buried metal of unknown type)

Legend:

— — — Ground Penetrating Radar Survey Line

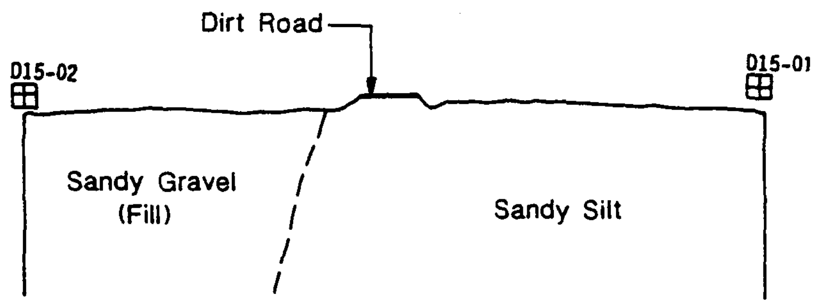
⊞ D15-01 Stage 3 Borehole

0 100 200ft
Scale

TERRAIN CONDUCTIVITY SURVEY
SITE D-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

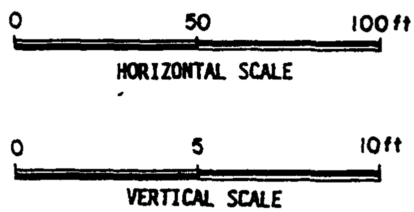
Figure
4.2.5.2



Legend:

D15-01 Test Boring

— — — Inferred Geologic Contact



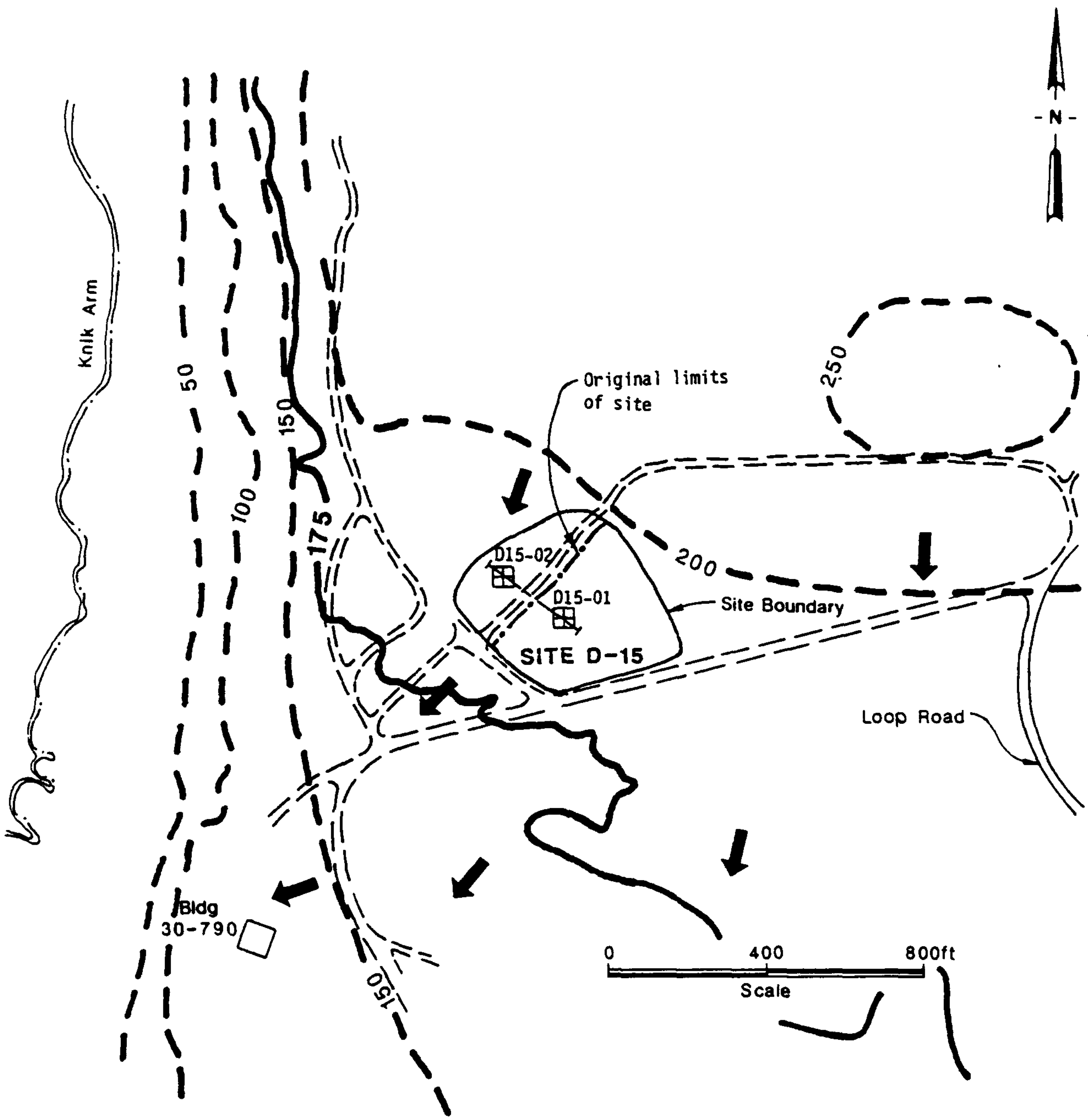
Notes:

1. Horizontal scale: 1 inch = 50 feet.
2. Vertical scale: 1 inch = 5 feet.
3. Geologic cross section shown on Figure 4.2.5.4

GEOLOGIC CROSS SECTION
SITE D-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.5.3



Legend:

D15-02 Stage 3 Borehole

230 Water table contour. Contour intervals: 50ft.

Approximate direction of groundwater flow.

300 Landsurface elevation contour. Contour intervals: 20ft.

Geologic Cross Section

HYDROGEOLOGIC MAP
SITE D-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.5.4

4.2.5.1.3 Analytical Results

Field analytical results and observations and laboratory analytical results are discussed in the following sections.

4.2.5.1.3.1 Field Analytical Results and Observations

Although some scattered debris was observed on the surface of the site, no odor or liquid waste was observed. The following observations were made during excavation of the borings:

- Boring D15-01 - An HNu reading of 0.2 ppm was recorded from the soil sample taken at 1 foot depth. No fuel odor was observed.

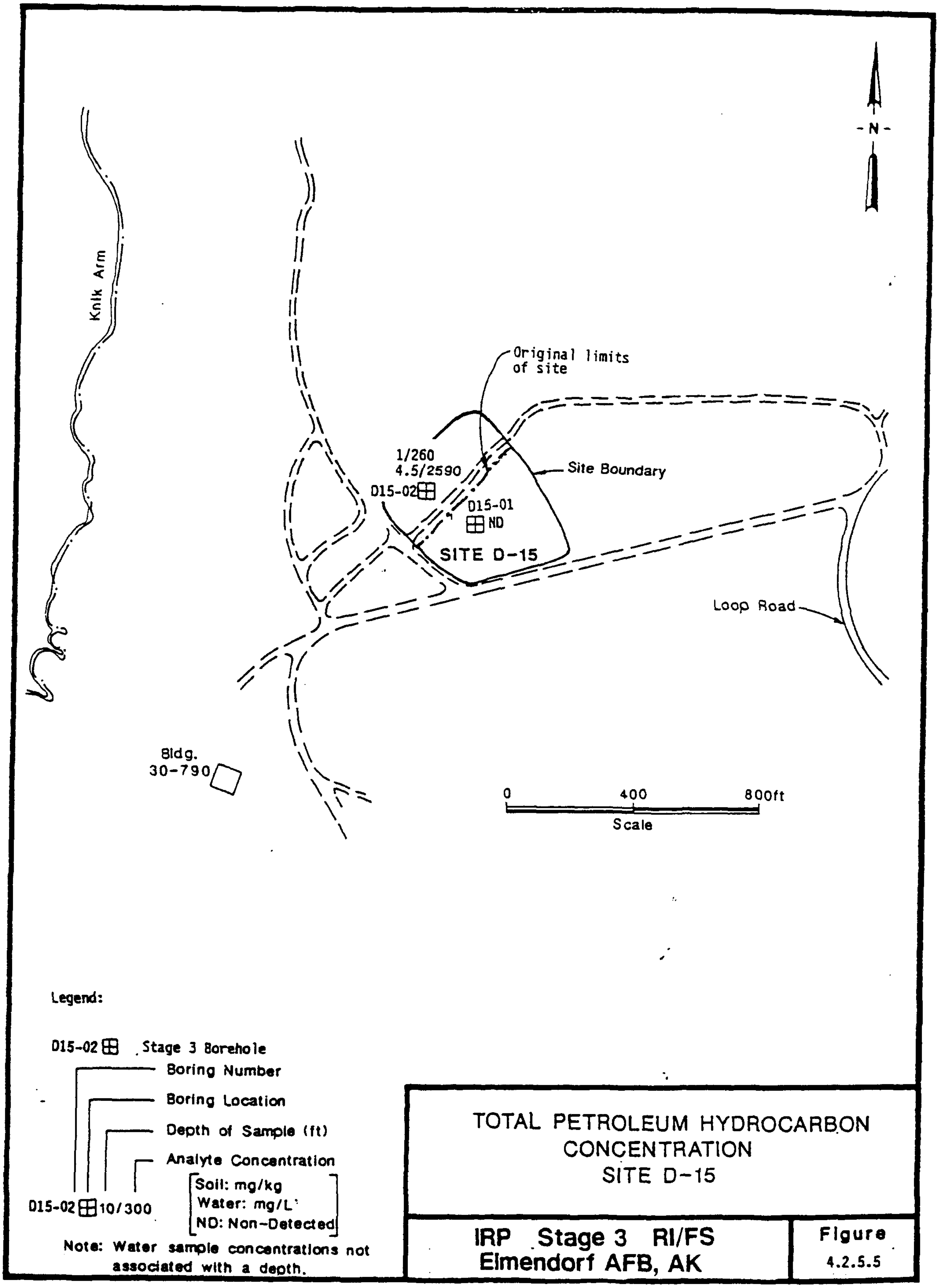
- Boring D15-02 - An HNu reading of 0.3 ppm (no odor) was recorded from the soil sample taken at 1 foot depth. On a soil sample taken at 3 feet an HNu reading of 10 ppm with a petroleum odor was recorded. On a soil sample taken at a depth of 5 feet, an HNu reading was 50 ppm with a strong petroleum odor was recorded.

4.2.5.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site D-15 is presented on Table 4.2.5.1, and the sample plan for the base-wide field investigation program is included in Appendix B. Results of analytical tests for lead, total solids and petroleum hydrocarbons are presented on Table 4.2.5.2. Total petroleum hydrocarbons detected at Site D-15 are shown on Figure 4.2.5.5.

4.2.5.1.4 Analytical Results Table

The laboratory analytical results for Site D-15 are presented on Table 4.2.5.2.



TOTAL PETROLEUM HYDROCARBON CONCENTRATION SITE D-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.5.5

Table 4.2.5.1. Requested Laboratory Analyses for Samples from Site D-15

SOIL

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
7421	Lead
160.3	Soil Moisture Content

Table 4.2.5.2

Analytical Results - Site D-15

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	D15-01 1'-1.5' 0687-SO-019,GS-88-0001 001206-0010	D15-01 4.5'-5' 0687-SO-019-GS-88-0002 001206-0011	D15-02 1'-1.5' 0687-SO-020 GS-88-0001 001221-0008	D15-02 4.5'-5.0' 0687-SO-020 GS-88-0002 001221-0010
Lead	7421	mg/kg	70	11.8	6.5	20	10
Total Petroleum Hydrocarbons	3550/418.1 Mod.	mg/kg				264	2593
Total Solids	160.3	%		79.5	92.4	94.6	96.4

4.2.5.1.5 Discussion of Analytical Data

Lead was detected at concentrations of 12 mg/kg from the surface at boring D15-01 and at 6.5 mg/kg from a 5-foot depth in this boring. Boring D15-02 soil samples contained total petroleum hydrocarbons (TPH) concentrations of 260 and 2,590 mg/kg at depths of 1 and 5 feet, respectively.

4.2.5.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site D-15 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the workplan.

4.2.5.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis were lost from site D-15.

4.2.5.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (See Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in samples from the site.

4.2.5.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Four soil samples were collected from 2 shallow borings at Site D-15. No out-of-control conditions occurred during drilling operations at the site.

4.2.5.3 Significance of Findings

The concentrations of lead detected in the soil samples from the site are within background levels and are below cleanup levels. The TPH concentration of 2,590 mg/kg is above interim State of Alaska soil cleanup level guidelines as described in Section 4.1. The probable source of the TPH contamination is the tank sludge, oil filters, and other POL wastes disposed of in the past.

4.2.5.3.1 Zones of Contamination

The field sampling crew did not observe surface stains in the vicinity of the boreholes. A 50 ppm HNu reading was recorded from soil samples taken at a depth of 5 feet from boring D15-02. A strong petroleum odor accompanied the reading, and chemical analysis of the soil confirmed the presence of petroleum hydrocarbons.

4.2.5.3.2 Contaminant Migration

Drilling and sampling operations at Site D-15 did not reach the groundwater. Therefore, it was not possible to determine if the groundwater is contaminated in the vicinity of Site D-15. Contamination of the groundwater by TPH at Site D-15 is possible because of the levels detected at 5 feet in boring D15-02.

4.2.5.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off-Base migration is unknown. The direction of subsurface flow in the vicinity of Site D-15 is thought to be to the southwest (Figure 4.2.5.4). Overall site dimensions are small and the nearest base boundary to the southwest of the site is less than 800 feet away. It is unknown if contamination from Site D-15 has entered the groundwater.

4.2.5.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

A hydrogeologic assessment at the site identified the direction of groundwater flow to be to the southwest with a gradient of about 50 feet per mile. Horizontal hydraulic conductivity was not estimated. It is unknown if groundwater is contaminated with materials buried at the site.

4.2.5.3.2.3 Time of Travel to Receptors

Primary receptors are humans, plants, and wildlife. Primary pathways are through contact with or ingestion of groundwater, and/or surface water. Time of travel to receptors is immediate since the surface soils are contaminated. Hydraulic conductivities have not been estimated for the site, but Cook Inlet is located less than 800 feet downgradient from the site.

4.2.5.3.2.4 Expected Spatial and Temporal Variations in Concentration

Groundwater flow is primarily toward the southwest of Site D-15. Groundwater was not sampled at this site; therefore, the spacial extent of contamination in the groundwater is unknown. A petroleum odor and positive HNu readings were detected in a soil sample taken at a depth of 5 feet from boring D15-02, and petroleum hydrocarbon contamination was detected in soil samples from boring D15-02. There is no available temporal data for the site.

4.2.5.3.3 Baseline Risk Assessment

Contamination with respect to possible receptors, exposure routes, and expected health effects are discussed in the following sections.

4.2.5.3.3.1 Waste Characterization

The primary wastes at this site are petroleum hydrocarbons. In general, petroleum hydrocarbons are not highly toxic but can have slight anesthetic effects.

4.2.5.3.3.2 Source and Release Characterization

The sources of petroleum hydrocarbons at Site D-15 is disposal of POL tank sludge and fuel filters and pads. Petroleum hydrocarbons were detected by laboratory analyses.

4.2.5.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons released into the environment at Site D-15 includes long-term natural degradation, dispersion through surface runoff or groundwater, or uptake by living organisms.

The occurrence of contaminant migration is unknown at the site since groundwater was not sampled.

4.2.5.3.3.4 Exposure Pathways

The exposure pathway for humans and wildlife is contact with or ingestion of contaminated soil and possibly ingestion of the ground and surface water and plants.

4.2.5.3.3.5 Identification of Receptors

Potential receptors are humans, plants, fish, and wildlife.

4.2.5.3.3.6 Threat to Human Health

The threat to human health from the site is not fully known since specific chemicals were not identified in the TPH analyses.

4.2.5.3.3.7 Carcinogenetic Risks

No carcinogenic contaminants were detected in soil samples from Site D-15; however, specific analytical tests would be required to make an accurate determination of the presence or absence of these compounds.

4.2.5.3.3.8 Threat to Wildlife

A threat to wildlife exists through the ingestion of potentially contaminated plants and surface water.

4.2.5.4 Prioritization of Sites for Remedial Alternatives

Site D-15 is assigned low priority for remedial alternatives due to the low toxicity of petroleum hydrocarbons. Further work at this site should include a soil gas survey to better characterize the area of contamination. Results of the soil gas survey should be used to place 3 monitoring wells at Site D-15. One of the wells should be located upgradient, 1 should be located near the boring SP15-02, and 1 located downgradient. The wells located near SP15-02 and downgradient should be dual completion wells to assess the vertical extent of contamination. Groundwater from wells should be sampled and tested for TPH and VOC's. If groundwater is shown to be uncontaminated, site remediation through the process of surface soil removal may be considered. A minimum of 2 soil samples should be collected from each of the 3 proposed borings/monitoring wells and analyzed for TPH and VOC's. In addition, soil samples taken within the site boundard should be analyzed for constituents regulated for disposal by the Anchorage Regional Landfill. These constituents include PCBs, arsenic, and chromium.

4.2.6 <u>Discussion of Results for Site D-16, POL Sludge Disposal Site No. 2</u>

Site D-16, also referred to as the POL Disposal Site No. 2, was used as a waste disposal area from the early 1970's to 1983 (Figure 4.2.6.1). The site consists of 3 separate concrete pads where fuel tank residue, fuel filters, and pads were placed to weather. Numerous filters remain at the site.

4.2.6.1 Presentation of Results for Site D-16

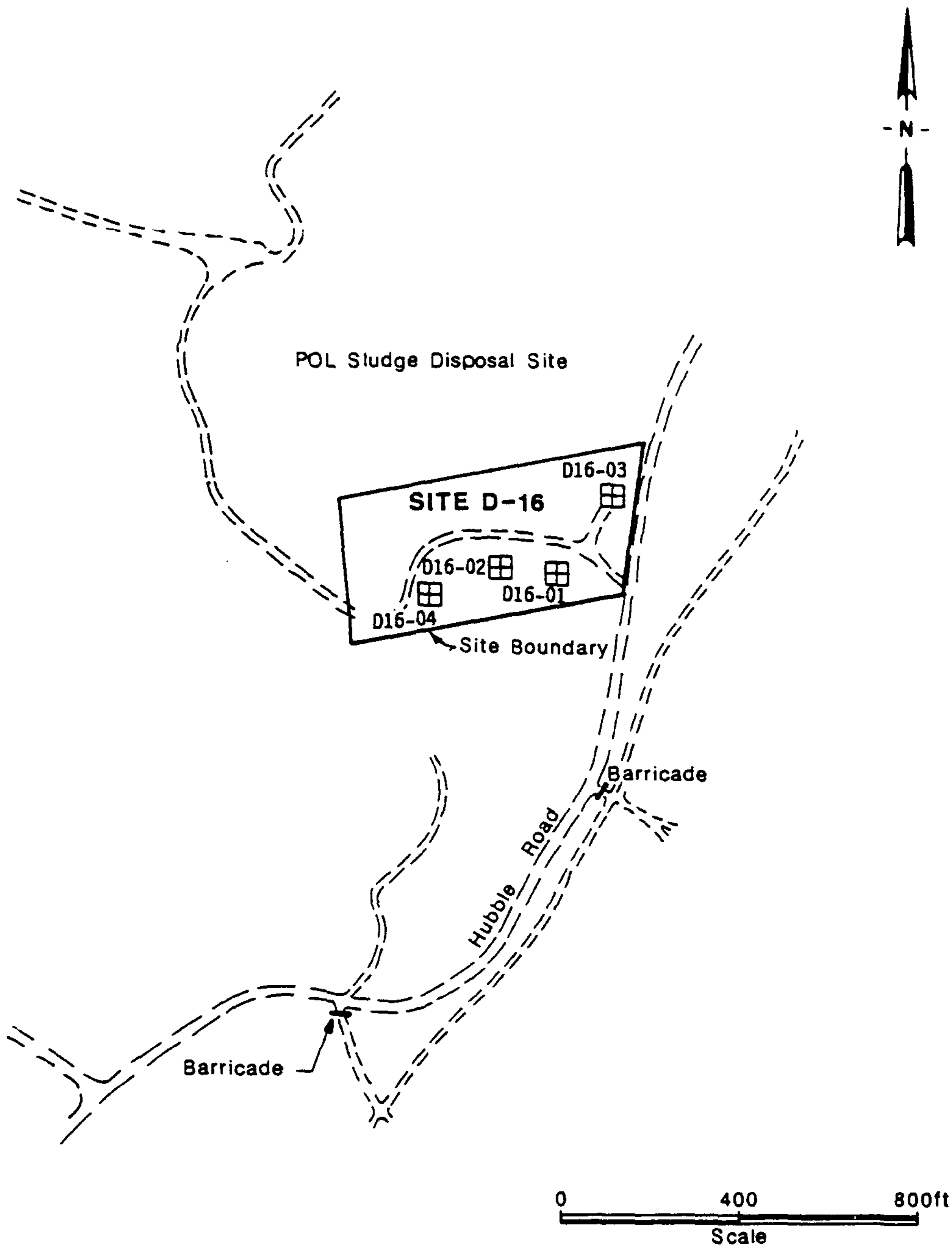
Results of the geologic and hydrogeologic investigations are presented below. Analytical results are tabulated and presented on the site maps.

4.2.6.1.1 Site Geology

The D-16 site is located at an elevation of 300 feet on late-Quaternary till deposits of the Elmendorf moraine. The site itself is fairly flat, but is situated in an area of hummocks and small low hills typical of kame and kettle topography. A schematic geologic cross section is shown on Figure 4.2.6.2. The site was partially overgrown with alders to a height of 10 feet. Four shallow soil borings were drilled at Site D-16. The borings were drilled to a depth of 5 feet and encountered mostly sands and gravels with varying amounts of silt. Logs of the borings are included in Appendix C.

4.2.6.1.2 Site Hydrogeology

Site D-16 is underlain at shallow depths by till composed of sands and gravels with silt and sand layers. Although no wells were drilled in this area, these deposits probably continue to depths of several tens of feet. Regional trends and the locations of nearby wetlands provide sufficient information for construction of a generalized hydrogeologic map (Figure 4.2.6.3). Site D-16 is located on the northeast side cf a groundwater divide, and groundwater at the site is assumed to flow



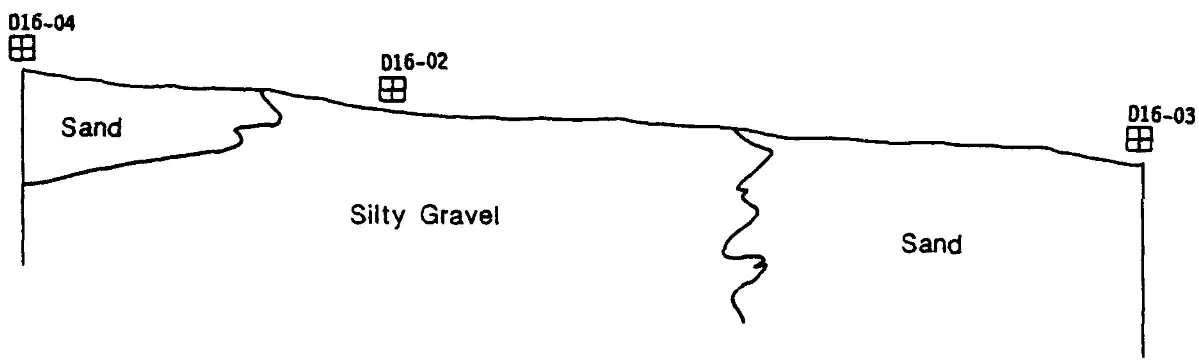
Legend:

D16-03 ⊞ Stage 3 Borehole

LOCATION MAP
SITE D-16

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.6.1



Legend:

D16-04 ⊞ Stage 3 Borehole

——— Geologic Contact

0 100 200ft
HORIZONTAL SCALE

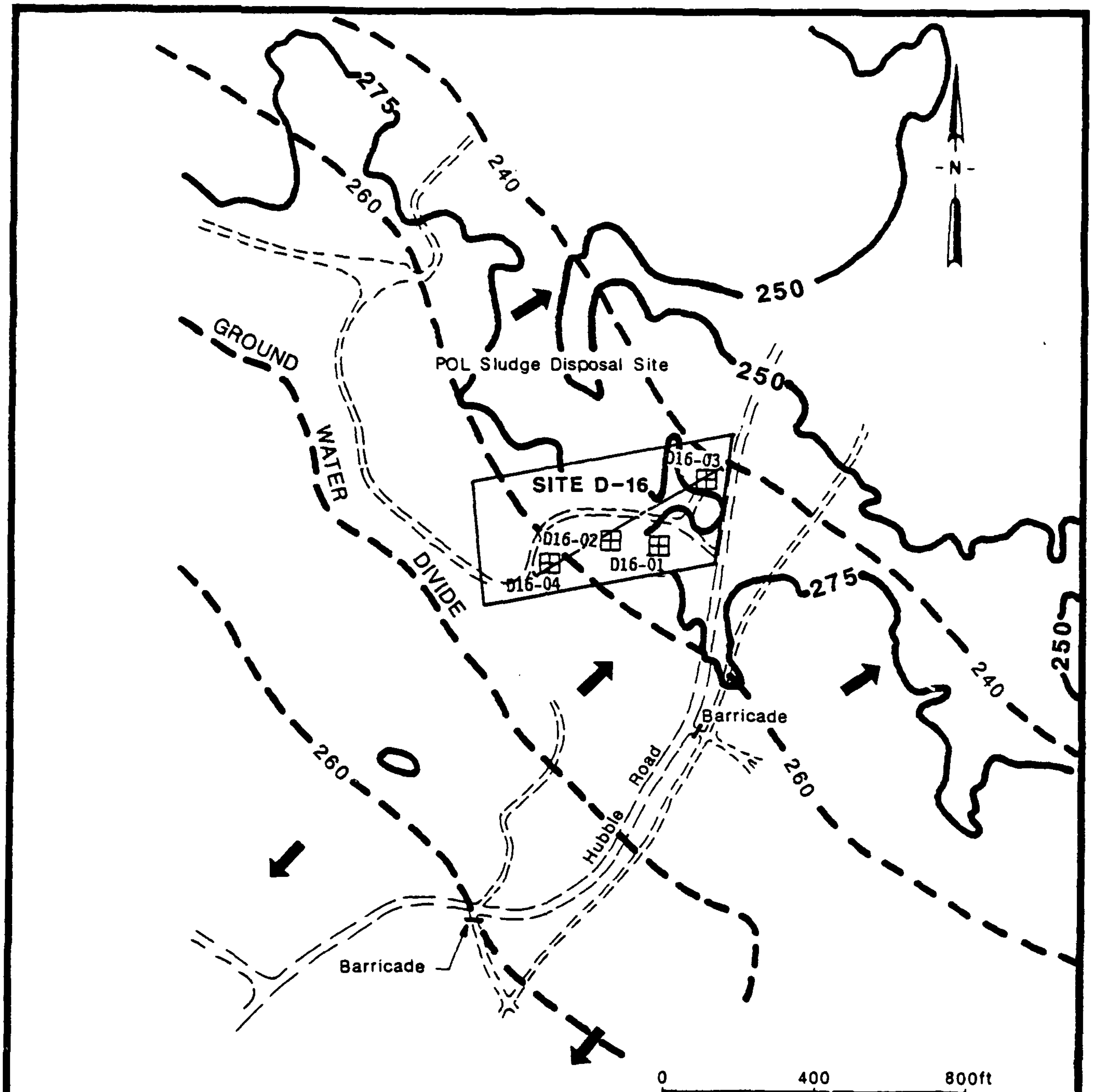
0 5 10ft
VERTICAL SCALE

Notes:

1. Horizontal scale: 1 inch = 100 feet.
2. Vertical scale: 1 inch = 5 feet.
3. Geologic cross section shown on Figure 4.2.6.3
4. Water table below a depth of 5 feet.

GEOLOGIC CROSS SECTION
SITE D-16

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.6.2



Legend:

D16-02⊞ Boring location

—230— Water table contour. Contour intervals: 20ft.

Approximate direction of ground-water flow

—300— Landsurface elevation contour. Contour intervals: 25ft.

Geologic Cross Section

HYDROGEOLOGIC MAP
SITE D-16

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.6.3

toward the northeast. The depth to groundwater at the site is probably in the range of 10 to 50 feet. Sand and gravel layers within the till would be expected to be the major water-bearing units. Hydraulic conductivities at the site would be expected to range over several orders of magnitude as a result of the heterogeneity of the deposits.

4.2.6.1.3 Analytical Results

Information on field observations and laboratory analyses are provided in the following sections.

4.2.6.1.3.1 Field Analytical Results and Observations

In addition to logging the statigraphy at each boring, an assessment of the presence of potential contaminants was made. The following observations were made during the examination of the borings:

- o Boring D16-01 - Silty gravel was encountered in the boring. No HNu readings above background level were noted and no petroleum odor was detected.

- o Boring D16-02 - Silty gravel was encountered in the boring. HNu readings of 160 ppm were noted and petroleum odor was detected on soil samples from 0.5 feet and 5 feet depths.

- o Boring D16-03 - Sandy soil was encountered in the borehole. No HNu readings above background level were noted, no petroleum odor was detected.

- o Boring D16-04 - Sands and silty gravel soils were encountered. HNu readings of 75 ppm were recorded, and petroleum odor was detected on soil samples at 0.5 feet and 5 feet depths.

4.2.6.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site D-16 is presented on Table 4.2.6.1, and the sample plan for the basewide field investigation program is included in Appendix B. Total petroleum hydrocarbon concentration identified from the laboratory analyses of samples collected at Site D-16 are plotted on Figure 4.2.6.4. The analyte concentrations are plotted next to the corresponding test boring. Sampling depths are included for the soil samples. Isoconcentration lines were not drawn due to the few points at which contamination were detected. Results of analytical tests are presented on Table 4.2.6.2.

Table 4.2.6.1. Requested Analyses for Laboratory Samples at Site D-16

SOIL/SEDIMENT

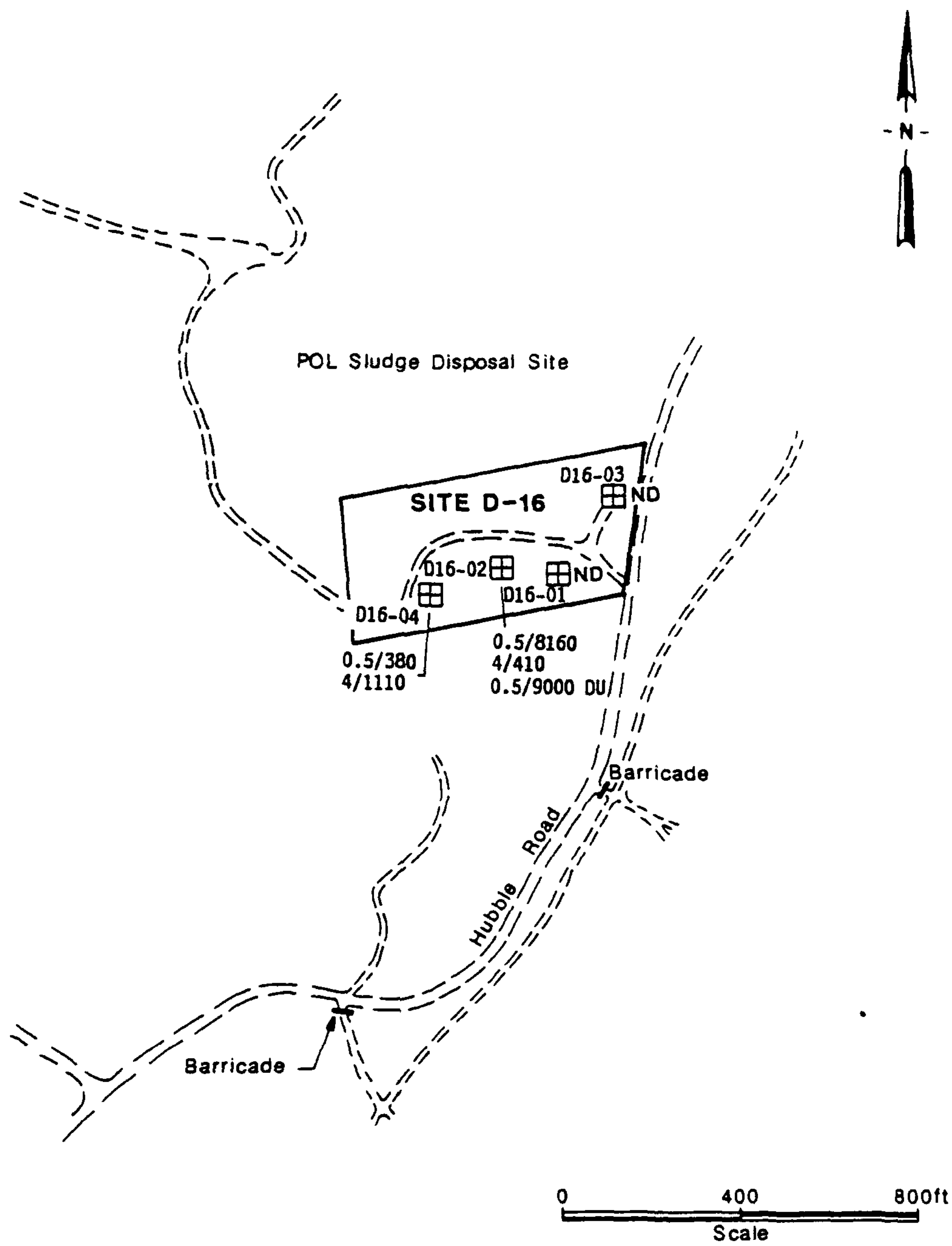
Test Number	Analysis
3550	Total Petroleum Hydrocarbons
7421	Lead
160.3	Moisture (Total Solids)

4.2.6.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site D-16 are presented on Table 4.2.6.2.

4.2.6.1.5 Discussion of Analytical Data

Total petroleum hydrocarbon compounds were detected in 2 of 4 test borings at Site D-16 (Figure 4.2.6.4). Soil from the surface at boring D16-02



Legend:

- Boring Number
- Boring Location
- Depth of Sample (ft)
- Analyte Concentration

D16-03 ⊞ 10/300

[Soil: mg/kg
Water: mg/L
ND: Non-Detected]

Note: Water sample concentrations not associated with a depth.

TOTAL PETROLEUM HYDROCARBON CONCENTRATION
SITE D-16

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.6.4

Table 4.2.6.2

Analytical Results - Site D-16

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	D16-01 0'-1' 0687-SO-021 GS-88-0001 000827-0006	D16-01 4'-5' 0687-SO-021 GS-88-0002 000827-0007	D16-02 .5'-1.5' 0687-SO-022 GS-88-0001 000827-0008	D16-02 .5'-1.5'duplicate 0687-SO-022 GS-88-0001 000827-0008	D16-02 4'-5' 0687-SO-022 GS-88-0002 000827-0009	D16-03 .5'-1.5' 0687-SO-023 GS-88-0001 000827-0010
Lead	239.1	mg/kg	70	44		33	33		
Total Petroleum Hydrocarbons	3550/418.1 Mod.	mg/kg				8163	8999	407	
Total Solids	160.3	%		92.0	93.7	92.8	90.9	88.5	88.2

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	D16-03 4'-5' 0687-SO-023 GS-88-0002 000827-0011	D16-04 .5'-1.5' 0687-SO-024 GS-88-0001 000827-0012	D16-04 4'-5' 0687-SO-024 GS-88-0002 000827-0013
Lead	239.1	mg/kg	70			
Total Petroleum Hydrocarbons	3550/418.1 Mod.	mg/kg			379	1114
Total Solids	160.3	%		95.1	95.0	90.7

contained petroleum hydrocarbons at a concentration of 8160 mg/kg; petroleum hydrocarbons were detected at a concentration of 410 mg/kg at the 5 foot depth. Soil from boring D16-04 contained lower concentrations of petroleum hydrocarbons (380 mg/kg) at the surface, increasing to 1110 mg/kg at a depth of 5 feet.

Lead was detected in soil samples from borings D16-01 and D16-02. Concentrations of lead were 43 mg/kg at the surface of boring D16-01 and 33 mg/kg in both the surface and 5-foot samples from boring D16-02.

4.2.6.2 Sampling and Analytical Problems

Sampling and analytical problems that could have been encountered at Site D-16 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the workplan.

4.2.6.2.1 Loss of Samples

No soil samples collected for laboratory analyses from Site D-16 were lost.

4.2.6.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (Section 3.6.2) were strictly followed during soil sampling. Laboratory QA/QC procedures (Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in samples from the site.

4.2.6.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Eight soil samples were collected from 4 shallow borings at Site D-16. No out-of-control conditions occurred during drilling operations.

4.2.6.3 Significance of Findings

Analytical methods detected petroleum hydrocarbons and lead in soil samples from Site D-16. All of the TPH concentrations are above the proposed State of Alaska soil cleanup levels as described in Section 4.1. The concentrations of lead detected in the soil samples from this site are similar to those at the background wells.

The sources of petroleum hydrocarbons in the soil are the tank sludge, oil filters, and other associated POL debris that were stored, spilled, and possibly buried at the site.

Pathways of exposure to contaminants are ingestion or handling of the contaminated soil by humans and wildlife or uptake by plants. If surface and groundwater is determined to be contaminated at this site, then ingestion by humans and wildlife, or uptake by plants constitutes an additional pathway.

4.2.6.3.1 Zones of Contamination

Organic contaminants were detected as total petroleum hydrocarbons in soil samples from borings D16-02 and D16-04. HNu readings of 160 and 75 ppm, respectively, and strong petroleum odors were observed during soil sampling activities. Total petroleum hydrocarbon concentrations increased with depth in boring D16-04, and decreased with depth in boring D16-02.

4.2.6.3.2 Contaminant Migration

Drilling and sampling operations at Site D-16 reached only to a depth of 5 feet which is above the depth of groundwater. Therefore, it was not possible to determine if the groundwater is contaminated in the vicinity of Site D-16. Contamination of the groundwater from sources at Site D-16 is possible since laboratory analysis did detect contamination in soils above the water table. This contamination may or may not have reached the water table.

4.2.6.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off-Base migration is unknown. The direction of groundwater flow in the vicinity of Site D-16 is assumed to be toward the northeast (Figure 4.1.6.3). This flow direction, however, has not been confirmed and it is not known if contamination from Site D-16 has entered the groundwater.

Offsite migration of contamination may also occur through surface runoff water containing organic contaminants from surface soils. Runoff water could quickly exit the site and flow down the nearby access road.

4.2.6.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site inferred that the direction of groundwater flow is toward the northeast. Horizontal hydraulic conductivity values are expected to range over several orders-of-magnitude.

4.2.6.3.2.3 Time of Travel to Receptors

The primary receptors at present are humans, wildlife and plants. Primary pathways are ingestion and handling of contaminated soil and plants. Time of travel to receptors is immediate since surface soils are contaminated. The site is remote, but accessible. In addition, surface runoff or accumulated precipitation may become contaminated by the soils. The surface runoff may flow toward a nearby road. A ditch paralleling the road may then carry the runoff further from the site. Again, time of travel is negligible.

4.2.6.3.2.4 Expected Spatial and Temporal Variations in Concentration

Since groundwater in the area of this site was not sampled as part of this study, the variations in contamination of the groundwater is unknown. Spatial variations in soil contamination are identified at borings D16-02 and D16-04 where total petroleum hydrocarbons were detected in soil samples. Surface contamination is highest in boring D16-02 and contamination at 5 feet deep is highest in boring D16-04. Neither borings D16-01 nor D16-03 had contamination. There is no available temporal data for the site.

4.2.6.3.3 Baseline Risk Assessment

Contamination based on potential receptors and health effects are evaluated in the following sections.

4.2.6.3.3.1 Waste Characterization

Petroleum hydrocarbons and lead have been detected at this site. Lead concentrations detected in soil samples are below similar background

levels. Specific types of hydrocarbons present have not been identified. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects.

4.2.6.3.3.2 Source and Release Characterization

Hydrocarbon compounds may have leached into surface and subsurface soils from POL filters, pads and sludges that were buried or left on the ground surface. The scope of this study did not include estimating the volume of contaminants released since exact quantities and types of materials buried were never recorded.

4.2.6.3.3.3 Fate and Transport of Contaminants

The fate of chemicals released to the environment at Site D-16 includes long-term natural degradation, dispersion of the contaminants through surface runoff or groundwater, and uptake by living organisms. The fate of metals in the environment includes oxidation, uptake by biological organisms, and/or chelation.

Nonsoluble contaminants can be transported from the site by percolation through the saturated groundwater zone and subsequent migration along hydrologic gradients. Dissolved contaminants would flow in the groundwater through the process of advection. Additional transport can occur in the form of surface runoff or release of vapor to the atmosphere. Finally, contaminated soil or water from the site can be transported through human intervention.

4.2.6.3.3.4 Exposure Pathways

At present, the exposure pathway for humans and wildlife is contact with, or ingestion of contaminated soils, groundwater (potentially), surface water runoff, or plants.

4.2.6.3.3.5 Identification of Receptors

Receptors are humans, wildlife, and plants. The site is a few hundred feet from a dirt road on the base. The road provides access to popular fishing and recreational areas, and is fairly well traveled. The site is easily accessed from the road. Wildlife is abundant in the heavily wooded area.

4.2.6.3.3.6 Threat to Human Health

A potential threat to human health from contaminated surface soils at Site D-16 exists. The site is easily accessible, surface soils are visibly stained, and strong petroleum odors are present. Specific chemicals have not been identified and exact health threats are not known.

4.2.6.3.3.7 Carcinogenic Risks

No carcinogenic compounds were detected by the analyses performed on soil samples from Site D-16. However, more specific tests are needed to determine the presence or absence of carcinogens.

4.2.6.3.3.8 Threat to Wildlife

Threat to wildlife is possible through contaminated surface soils, plants, or surface water runoff from the site.

4.2.6.4 Prioritization of Sites for Remedial Alternatives

Site D-16 is assigned a low priority for further investigation regarding groundwater contamination due to the low toxicity of petroleum hydrocarbons and the remoteness of the site. However, because the TPH contamination exceeds the State of Alaska Interim Soil and Groundwater Cleanup Guidelines, a feasibility study should be

performed for evaluation of soil remediation alternatives. Further investigation at this site should include a soil gas survey to better characterize the area of contamination. Results of the soil gas survey could be used to select locations for 4 monitoring wells and 1 new shallow boring at Site D-16. This shallow boring will be drilled to provide additional information on soil contamination. Two of the new monitoring wells, 1 in the area of known soil contamination and 1 downgradient, should be completed, screened, and sampled in both the upper and lower regions of the unconfined aquifer to delineate the vertical extent of contamination. Groundwater from the proposed wells should be sampled and tested for TPH and VOCs. A minimum of 2 soil samples should be collected from each of the 7 proposed borings and analyzed for TPH and VOCs. In addition, soil samples taken within the site boundary should be analyzed for constituents regulated for disposal by the Anchorage Regional Landfill. These constituents include PCBs, arsenic, and chromium.

4.2.7 Discussion of Results for Site D-17, Shop Waste Disposal

Site D-17 (Figure 4.2.7.1) covers an area of approximately 12.5 acres. A trench in the vicinity of this site which covered an area of less than 1 acre was used during the 1950's and 1960's as a disposal area for waste solvents, paint thinners, and other liquids generated in shop operations (Engineering-Science, 1983). The materials were poured directly onto the permeable soil. The area has since been covered with local soil.

4.2.7.1 Presentation of Results for Site D-17

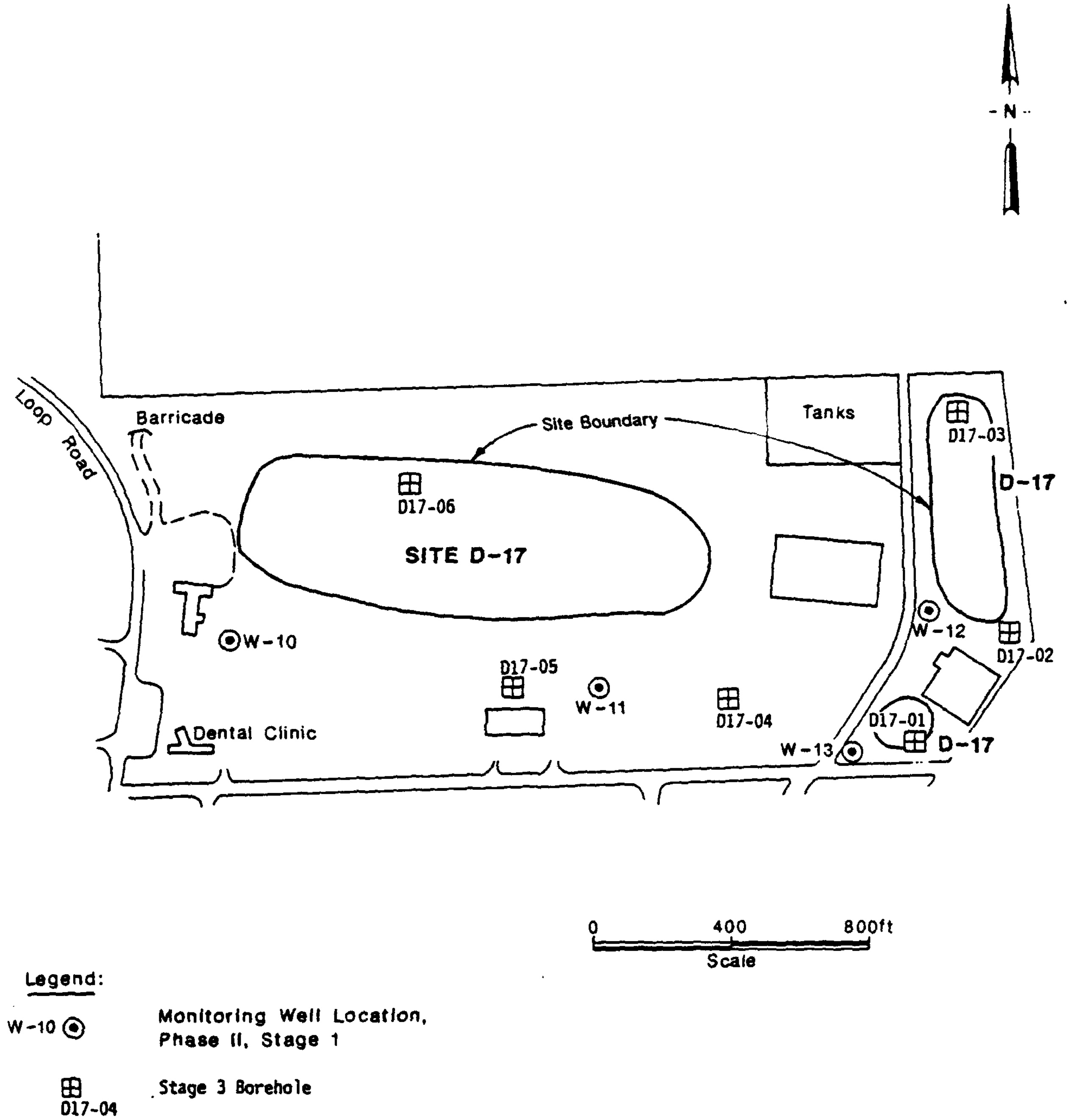
Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site maps.

4.2.7.1.1 Site Geology

Site D-17 is located at an elevation of 150 feet on flat terrain underlain by surficial deposits of late-Quaternary glacial outwash consisting chiefly of coarse sands and gravels. The surficial outwash deposits overlie clayey soil of the Bootlegger Cove Formation at depths ranging from 10 to 45 feet. Part of the site is occupied by several buildings and unpaved parking areas although most of the site has been planted with grass. A schematic geologic cross section is presented on Figure 4.2.7.2.

4.2.7.1.1.1 Borings

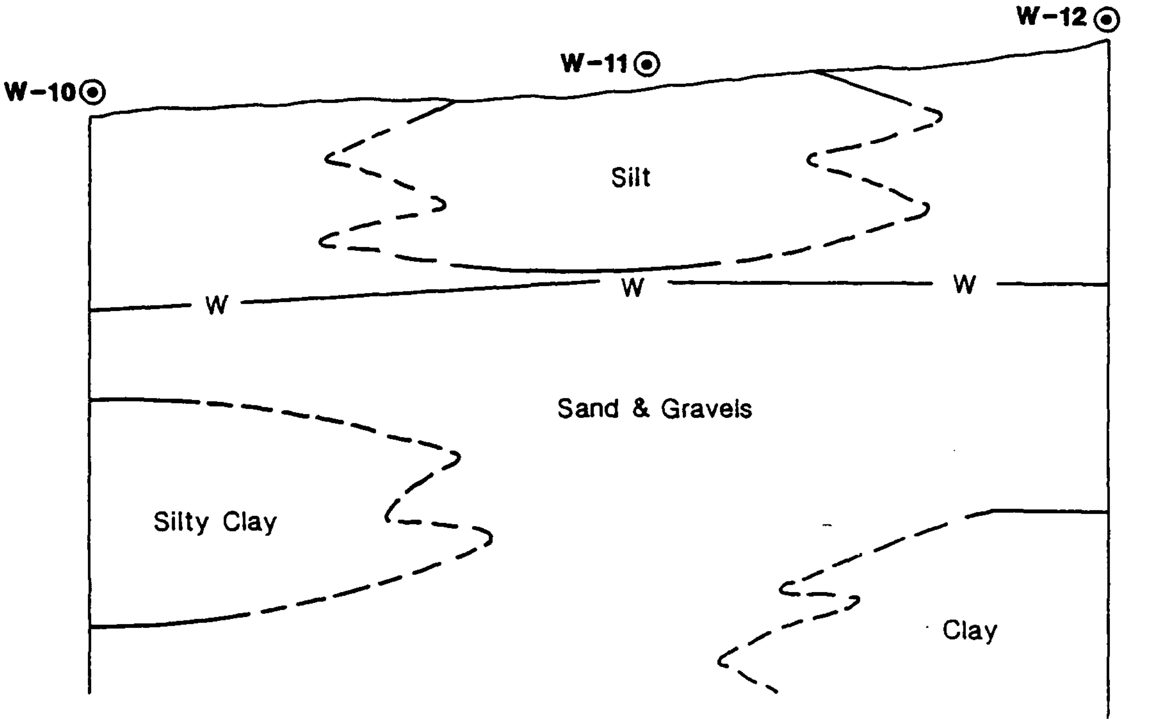
Six 5-foot deep soil borings were drilled at the locations shown on Figure 4.2.7.1. Also shown on Figure 4.2.7.1 are the locations of 4 monitoring wells drilled in 1984. All borings encountered dense coarse sands and gravels to the total depth of the hole. Detailed logs of the borings are provided in Appendix C.



LOCATION MAP
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.7.1

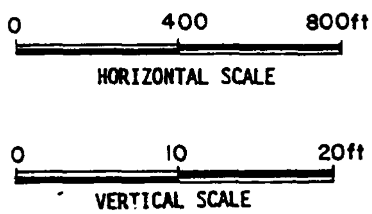


Legend:

W-10 ⊙ Monitoring Well, Phase II, Stage I

— W — Projected Water Table

—— ---- Geologic Contact, Dashed Where Inferred



Notes:

1. Horizontal scale: 1 inch = 400 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Geologic cross section shown on Figure 4.2.7.3

GEOLOGIC CROSS SECTION
SITE D-17

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.7.2

4.2.7.1.2 Site Hydrogeology

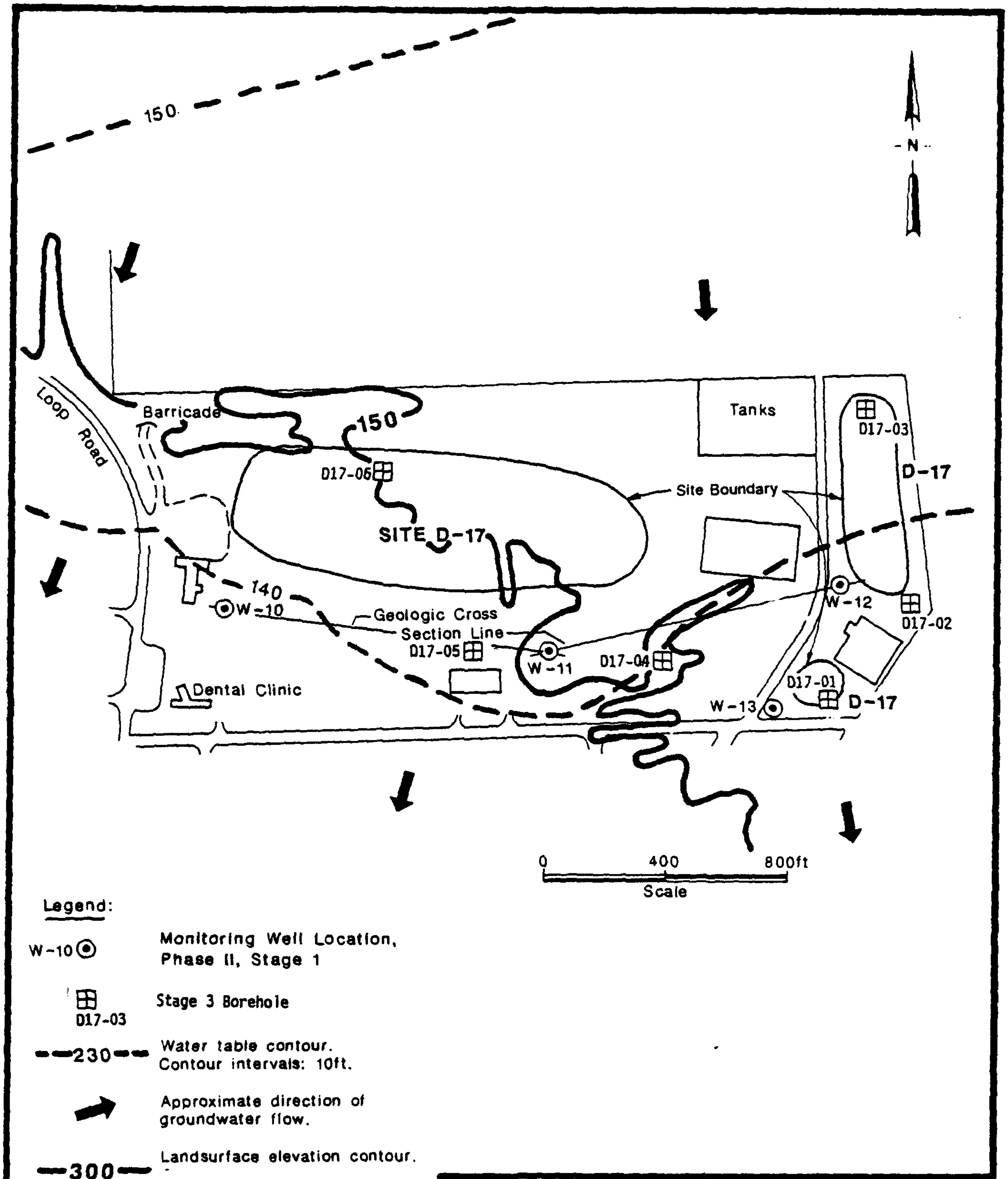
Site D-17 is underlain by sands and gravels with some silts. The water table was encountered at a depth of approximately 10 to 15 feet in well W-11 and approximately 15 feet at well W-13. The direction of groundwater flow is based on comparison of regional trends with water-level measurements at wells W-11 and W-13 (Figure 4.2.7.3). The direction of groundwater flow is south with a gradient of approximately 50 feet per mile. The position of the water table in this area is locally influenced by drainage ditches, storm drains and dry wells. A slug test was conducted at well W-13 at Site D-17 and a hydraulic conductivity value of 5.9×10^{-2} feet per day was calculated. However, this value may not representative of hydraulic conductivities in the area because the geologic log for the well reports the presence of gravelly sands and sands with traces of silt at the screened interval. The well is suspected of being partially plugged by sediments or organic and mineral precipitates.

4.2.7.3 Analytical Results

Field analytical results and observations, and laboratory analytical results are discussed in the following sections.

4.2.7.1.3.1 Field Analytical Results and Observations

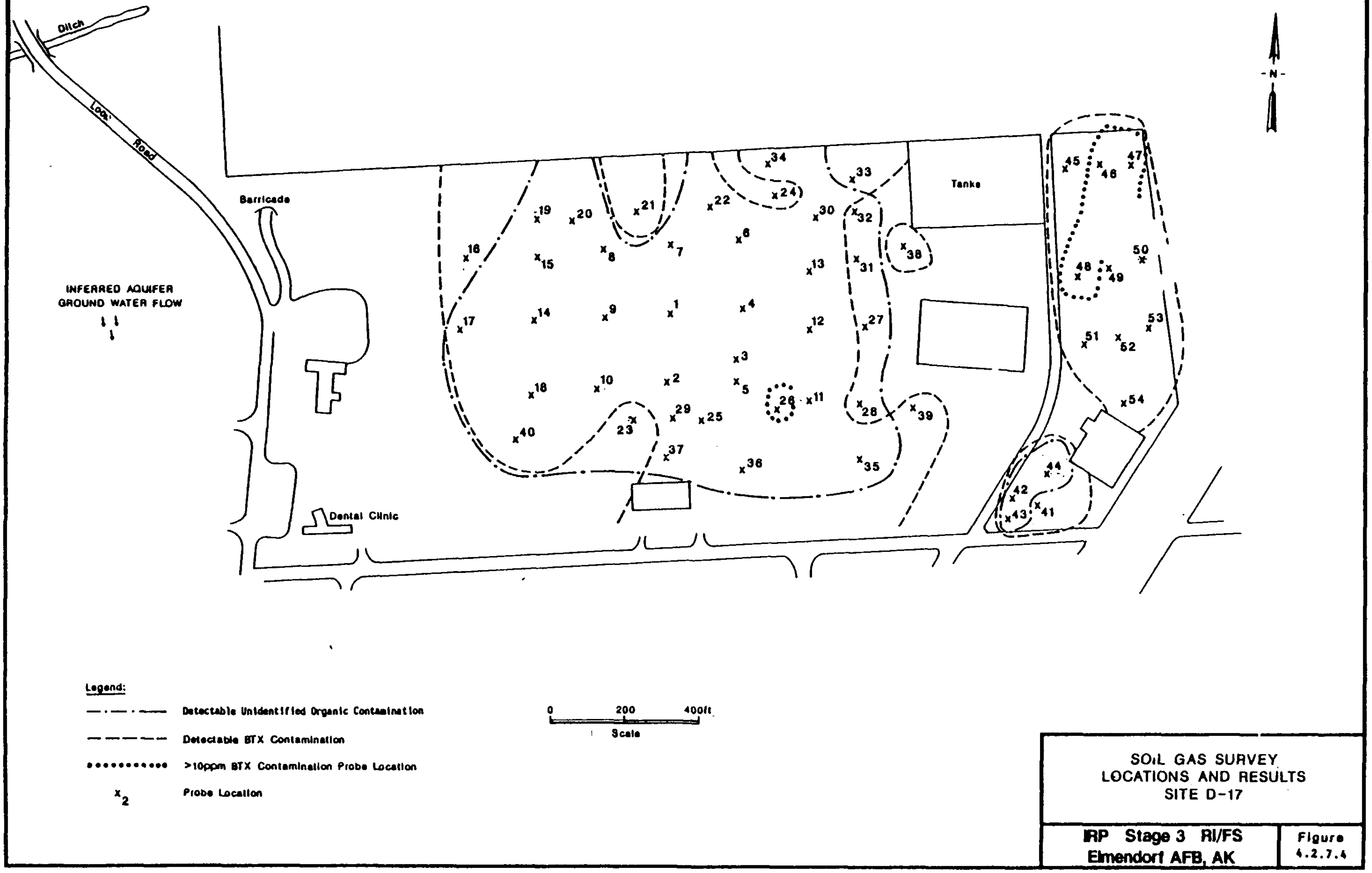
Results of a soil gas survey conducted at Site D-17 are presented on Figure 4.2.7.4 and in Table 4.2.7.1. Isoconcentration contours have been drawn based on findings of the field analysis. In addition to



HYDROGEOLOGIC MAP
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.7.3



SOIL GAS SURVEY
LOCATIONS AND RESULTS
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.7.4

Table 4.2.7.1 Summary of Soil Gas Chromatograph Analyses at Site D-17

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)
1	5	-	.25	TR	.69
	10	-	.53	-	.08
2	5	-	.24	TR	.01
	7	-	.85	.06	.03
3	5	-	.31	TR	.29
	7.5	.11	.13	-	.42
4	5	-	3.88	-	-
	10	-	.31	TR	TR
5	5	-	.85	-	.21
	8	.97	-	.43	.21
6	5	-	1.4	-	.19
	10	1.13	TR	TR	.25
7	5	-	.56	TR	.25
8	5	.09	.03	.05	TR
9	6.5	2.68	.23	.62	.35
10	5	-	1.2	-	.18
11	5	-	.16	TR	.14
12	5	-	.09	TR	.86
	10	-	.31	.14	.49
13	5	.37	.14	-	.36
14	10	-	.16	-	.06
15	5	-	TR	-	.03
16	5	-	1.08	TR	-
17	5	-	.52	.64	.14
18	5	-	.06	TR	.06
19	5	-	.32	-	.09
	10	-	.70	-	.09
20	5	-	.17	TR	.19
21	5	-	TR	TR	-
22	5	-	.17	TR	.02
23	5	-	TR	TR	.05
24	5	-	TR	TR	.14
25	5	-	.58	TR	.20
26	5	-	.49	-	.05
	10	17	-	-	.03
27	5		TR	TR	.54
28	10	-	TR	TR	1.44
29	10	-	.47	TR	.43
30	5	-	.11	TR	.14
31	5	-	TR	TR	.23
32	5	-	TR	TR	.31
33	5	-	.31	.33	.31

Table 4.2.7.1 (Cont'd.) Summary of Soil Gas Chromatograph Analyses at Site D-17

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)
	10	7.12	TR	-	-
34	5	-	.38	TR	.28
	10	-	.26	.76	.29
35	6.5	2.8	-	-	.19
36	5	-	.23	TR	.02
37	5	TR	2.7	-	.10
38	7.5	.26	.94	-	.29
39	5	.03	.18	TR	-
40	3.5	TR	1.35	-	.15
41	5	-	1.46	.165	-
	10	.11	-	-	-
42	3.5	.49	3.17	TR	.07
43	5	-	1.16	TR	.27
44	5	1.49	6.4	-	.05
	7.5	.07	.16	TR	.28
45	5	.05	3.97	-	.47
46	5	-	16	-	.91
47	5	-	17	-	.56
48	6.5	-	16	TR	.58
49	5	-	1.12	.93	.46
50	5		9.1		.32
51	8	5	TR	TR	.09
52	5	.07	1.1	-	.45
53	5	-	2.3	TR	.46
54	5	7	-	TR	.34

Note: Unidentified organics are reported in benzene equivalent ppm.
TR - Trace

the soil gas survey, visual observations of potential contaminants were made in the field at all subsurface investigative sites. At several boring locations there were no indications of contamination either as stains, petroleum odor or HNu readings. The sites with no indications of contamination included boreholes D17-02, D17-03, D17-04, D17-05 and D17-06. Evidence of contamination was observed at borehole D17-01. Although there was no petroleum odor, HNu readings of 2 ppm on a soil sample taken at a depth of 1-foot and 1.5 ppm on a soil sample taken at a depth of 5 feet were measured at borehole D17-01.

Field parameters measured at Site D-17 during groundwater sampling are presented in Table 4.2.7.2.

4.2.7.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site D-17 is presented in Table 4.2.7.3, and the sample plan for the base-wide field investigation program is included in Appendix B. Major organic contaminants identified from the laboratory analysis of samples collected at Site D-17 are plotted on Figures 4.2.7.5 through 4.2.7.17. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well or test boring. Sampling depth is included for the soil samples. Isoconcentration lines were not drawn due to the few points having detectable contamination for each analyte. Results of analytical tests for metals and other contaminants are presented in Table 4.2.7.4.

4.2.7.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site D-17 are presented in Table 4.2.7.4.

Table 4.2.7.2 Field Parameters Site D-17

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
W-11	8/22/88	6.2	795	7.35	500	No odor or sheen
W-13	8/22/88	8.0	510	7.39	366	No odor or sheen

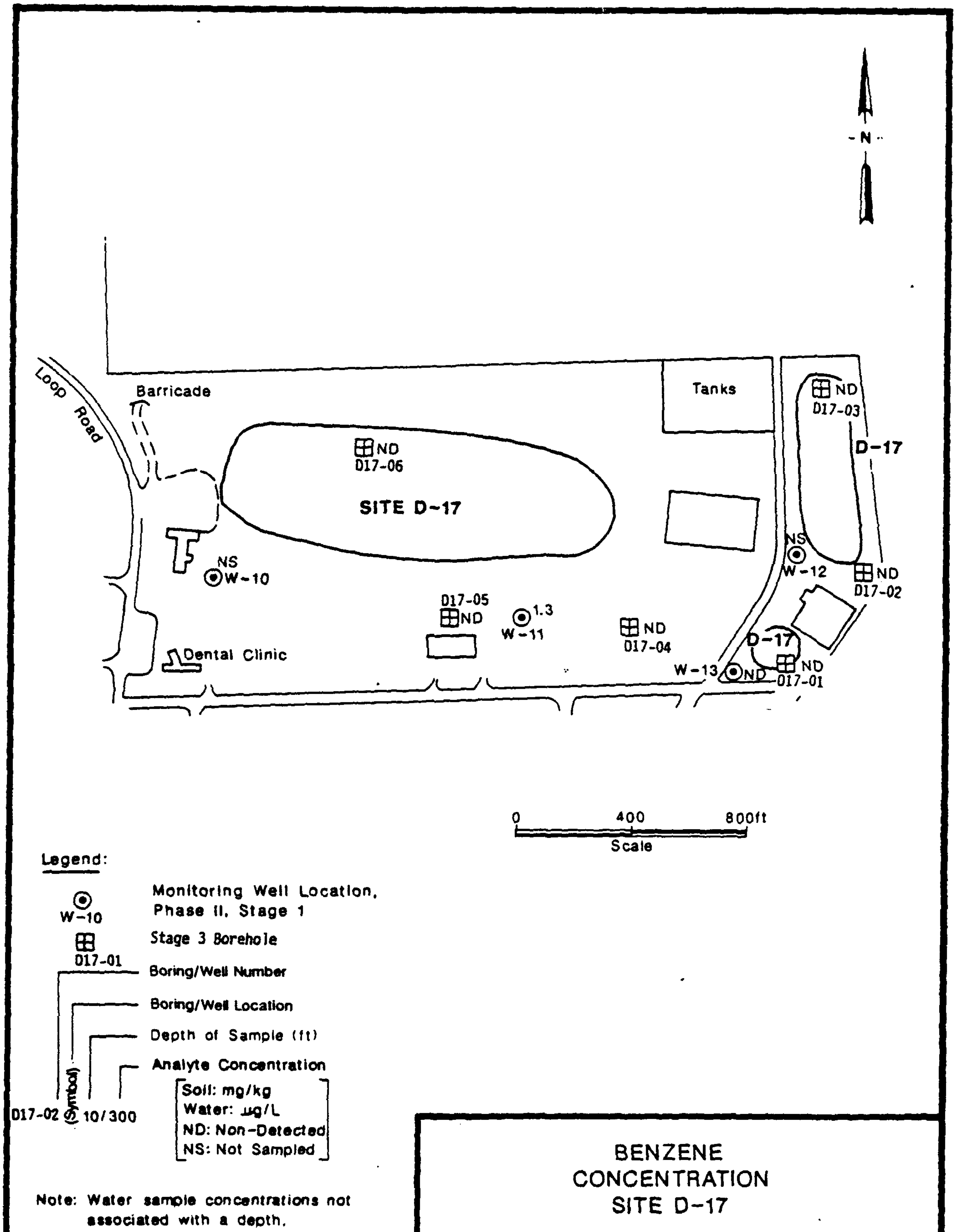
Table 4.2.7.3 Requested Laboratory Analyses for Samples from Site D-17.

SOIL/SEDIMENT

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
6010	ICP Screen (25 metals)
7471	Mercury
8080	Organochlorine Pesticides and PCBs
8240	Volatile Organic Compounds
8270	Semi-volatile Organic Compounds
160.3	Soil Moisture Content

WATER

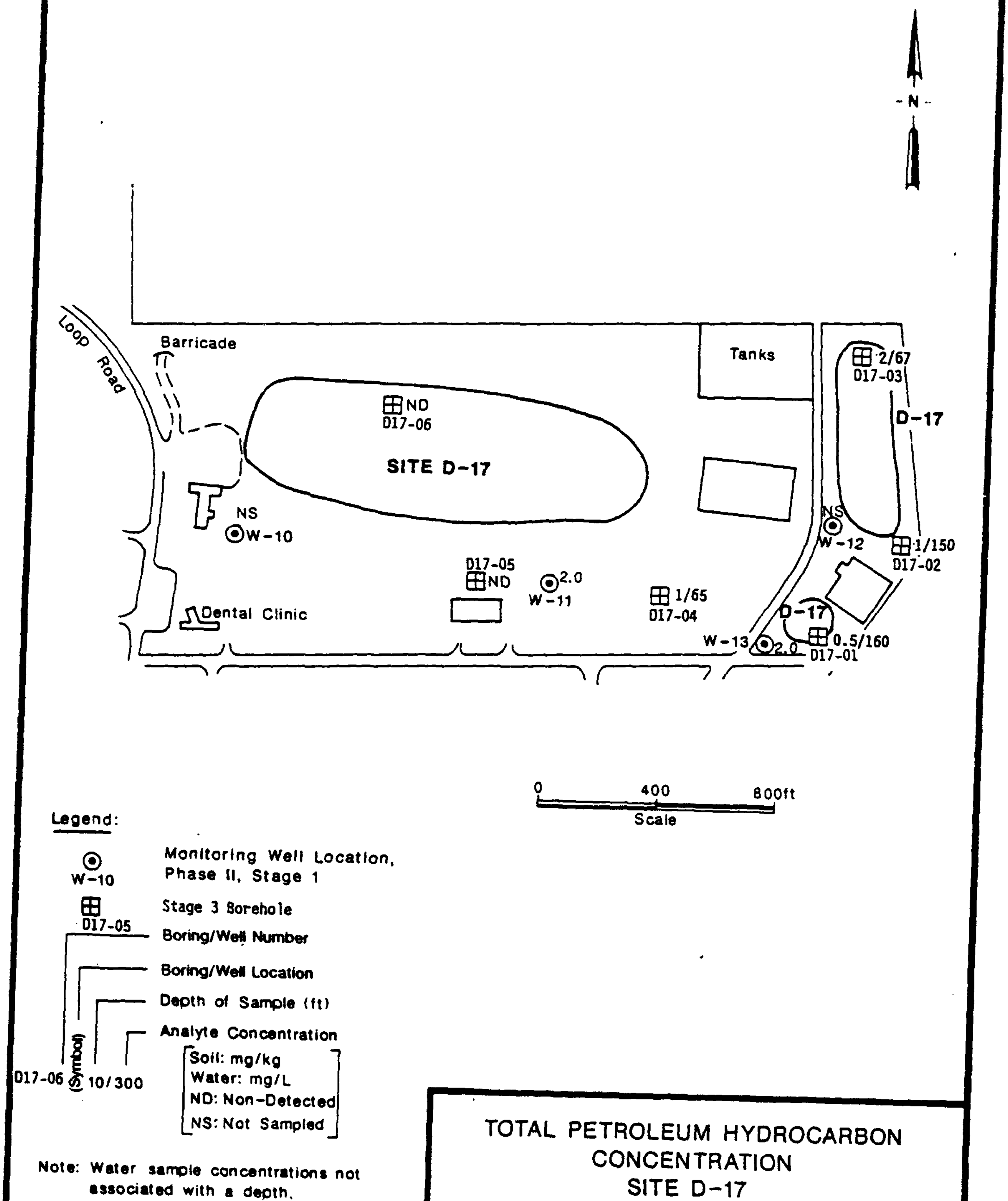
Test Number	Analysis
300	Common Anions
418.1	Petroleum Hydrocarbons
200.7	ICP Screen (total and dissolved)
206.2	Arsenic (total and dissolved)
239.2	Lead (total and dissolved)
245.1	Mercury (total dissolved)
270.2	Selenium (total and dissolved)
601	Purgeable Halocarbons
624	Non-Halogenated Volatile Organics
602	Purgeable Aromatics
608	Organochlorine Pesticides and PCBs
625	Extractable Priority Pollutants



BENZENE
CONCENTRATION
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

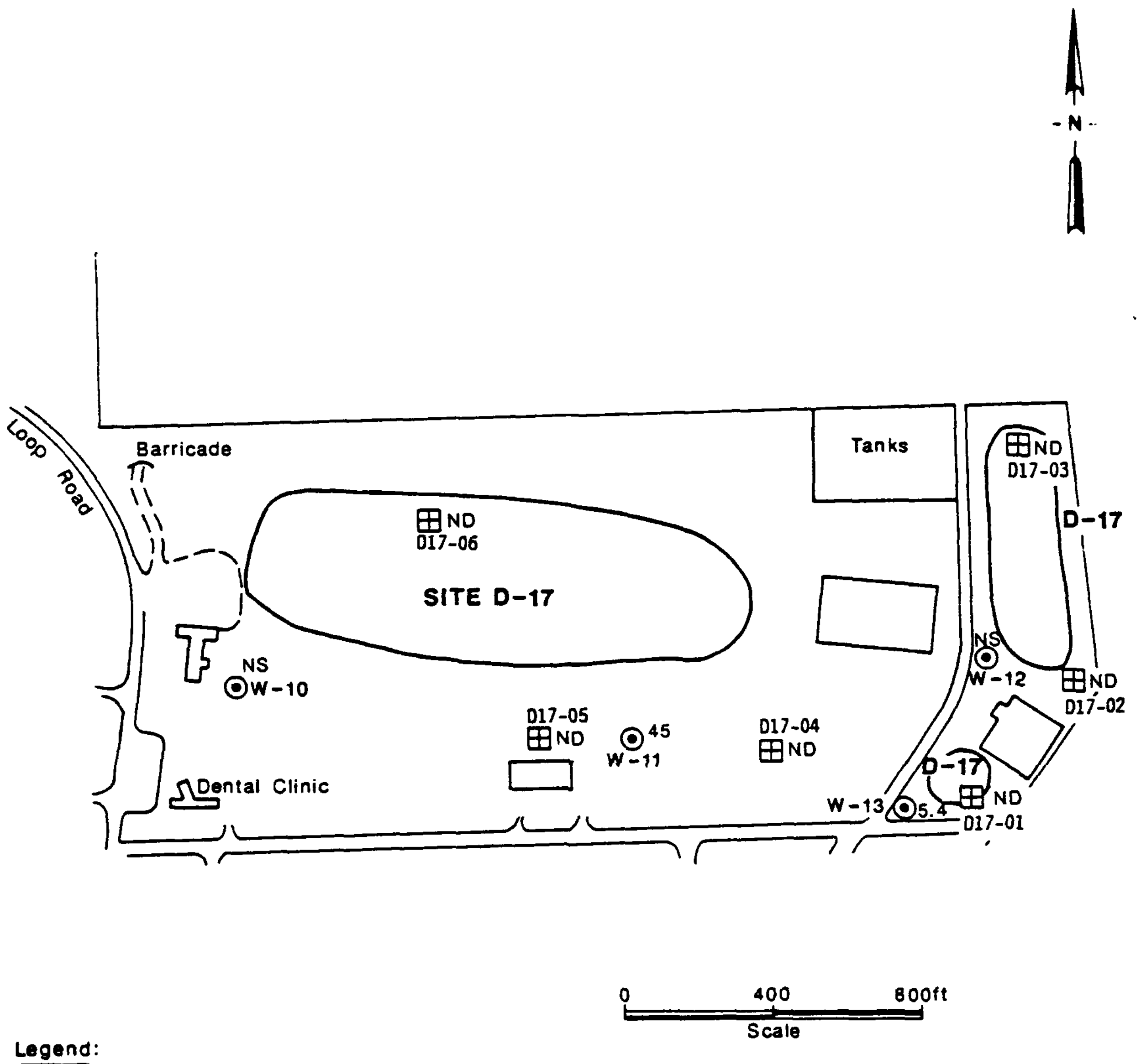
Figure
4.2.7.5



TOTAL PETROLEUM HYDROCARBON CONCENTRATION SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.7.6



Legend:

Monitoring Well Location, Phase II, Stage 1 (W-10)

Stage 3 Borehole (017-05)

Boring/Well Number

Boring/Well Location

Depth of Sample (ft)

Analyte Concentration

017-04 (Symbol) 10/300

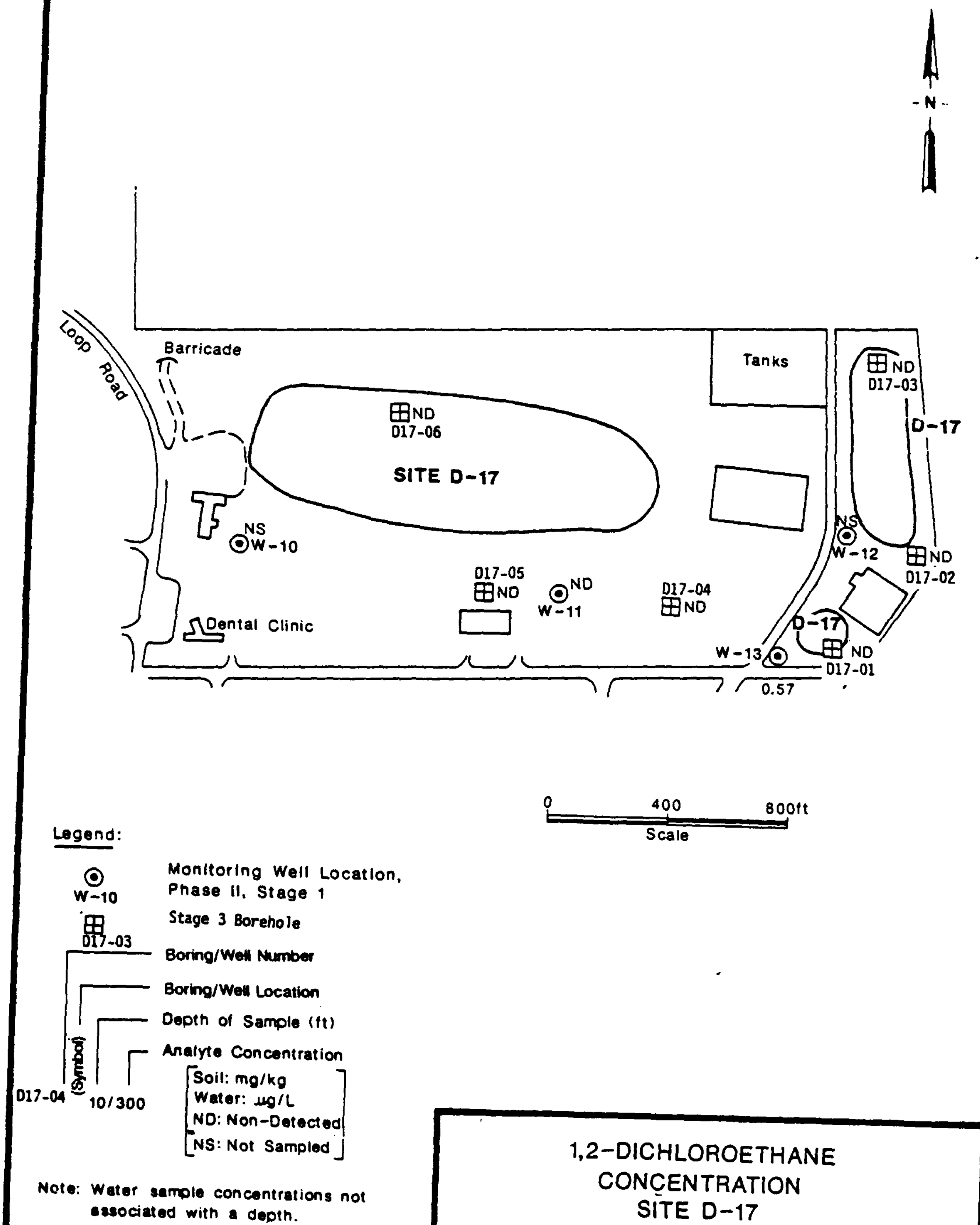
[Soil: mg/kg
Water: µg/L
ND: Non-Detected
NS: Not Sampled]

Note: Water sample concentrations not associated with a depth.

TRICHLOROETHENE
CONCENTRATION
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

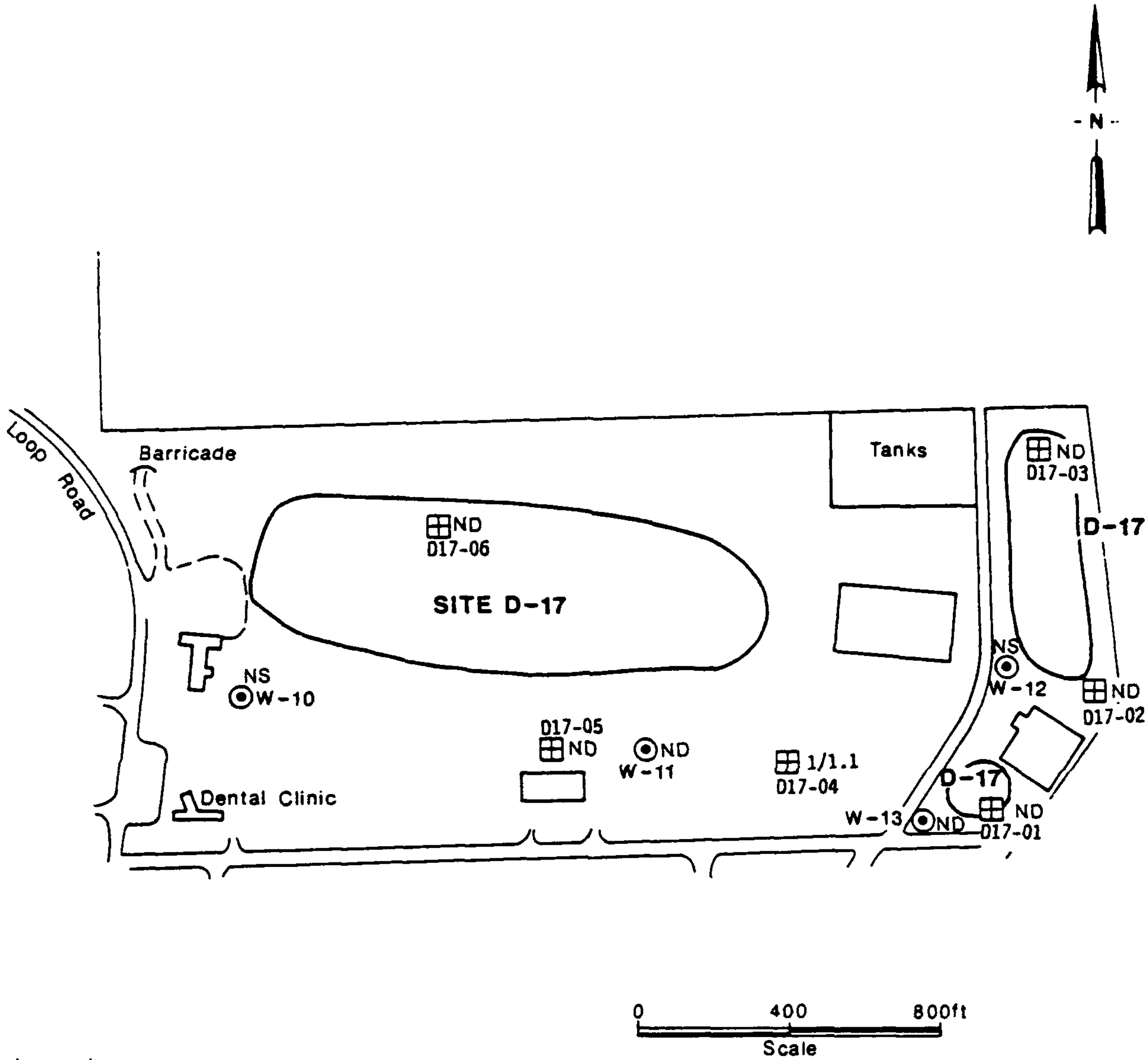
Figure 4.2.7.7



1,2-DICHLOROETHANE
CONCENTRATION
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.7.8



Legend:

W-10 — Monitoring Well Location, Phase II, Stage 1

017-01 — Stage 3 Borehole

Boring/Well Number

Boring/Well Location

Depth of Sample (ft)

Analyte Concentration

017-02 (Symbol) 10/300

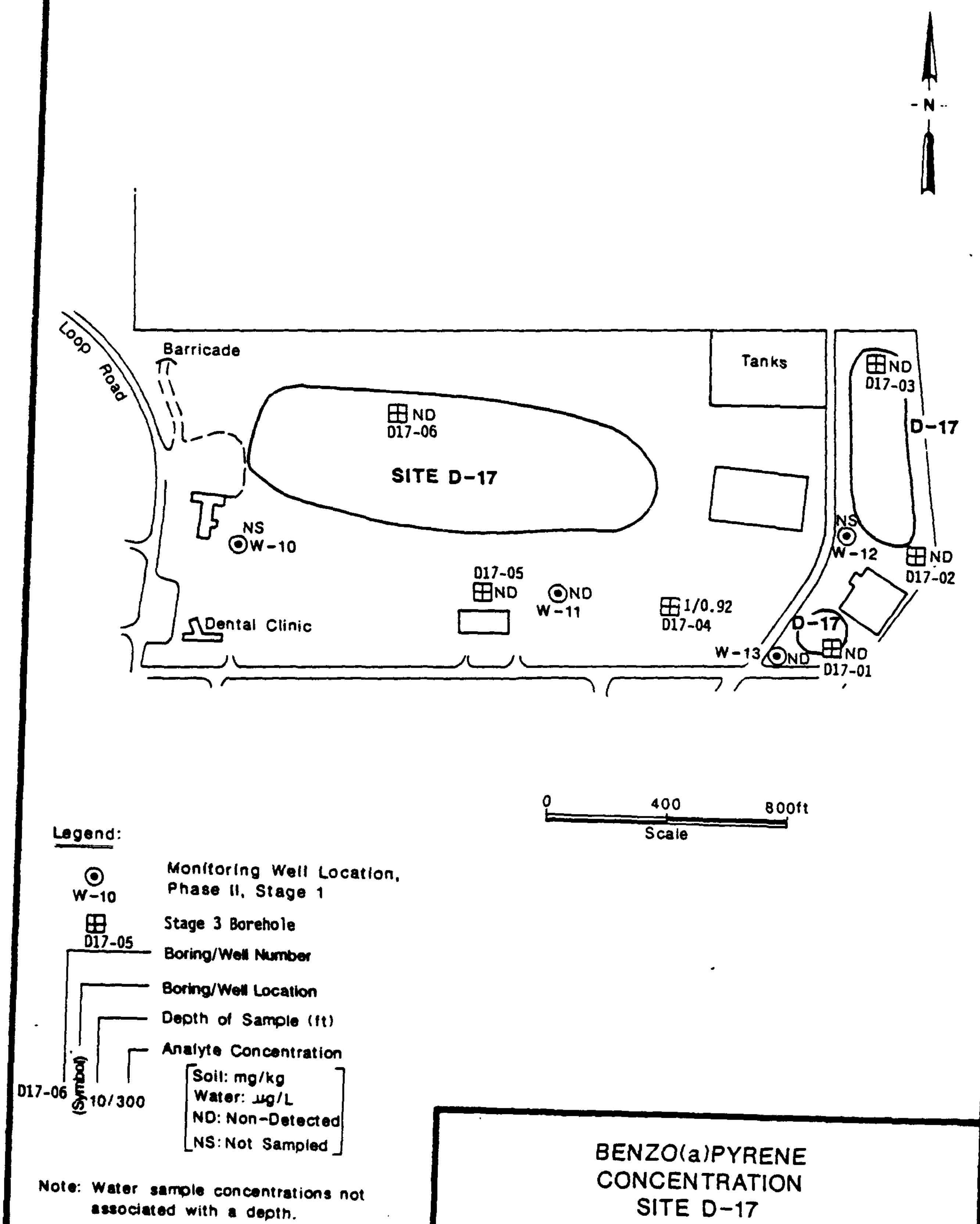
Soil: mg/kg
Water: µg/L
ND: Non-Detected
NS: Not Sampled

Note: Water sample concentrations not associated with a depth.

BENZO(a)ANTHRACENE
CONCENTRATION
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

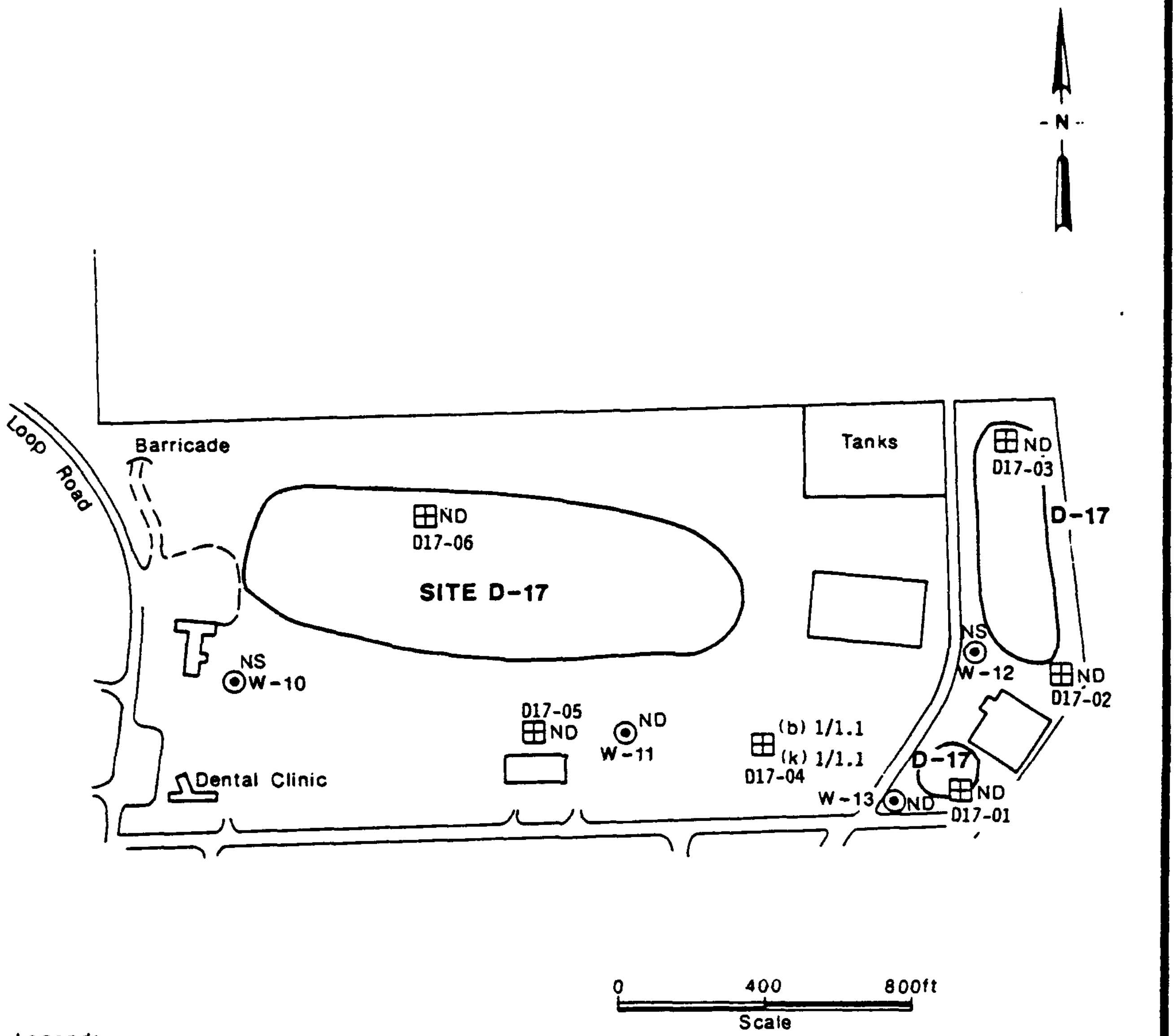
Figure
4.2.7.9



BENZO(a)PYRENE
CONCENTRATION
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure. 4.2.7.10



Legend:

W-10 — Monitoring Well Location, Phase II, Stage 1

D17-03 — Stage 3 Borehole

Boring/Well Number

Boring/Well Location

Depth of Sample (ft)

Analyte Concentration

D17-04 (Symbol) 10/300

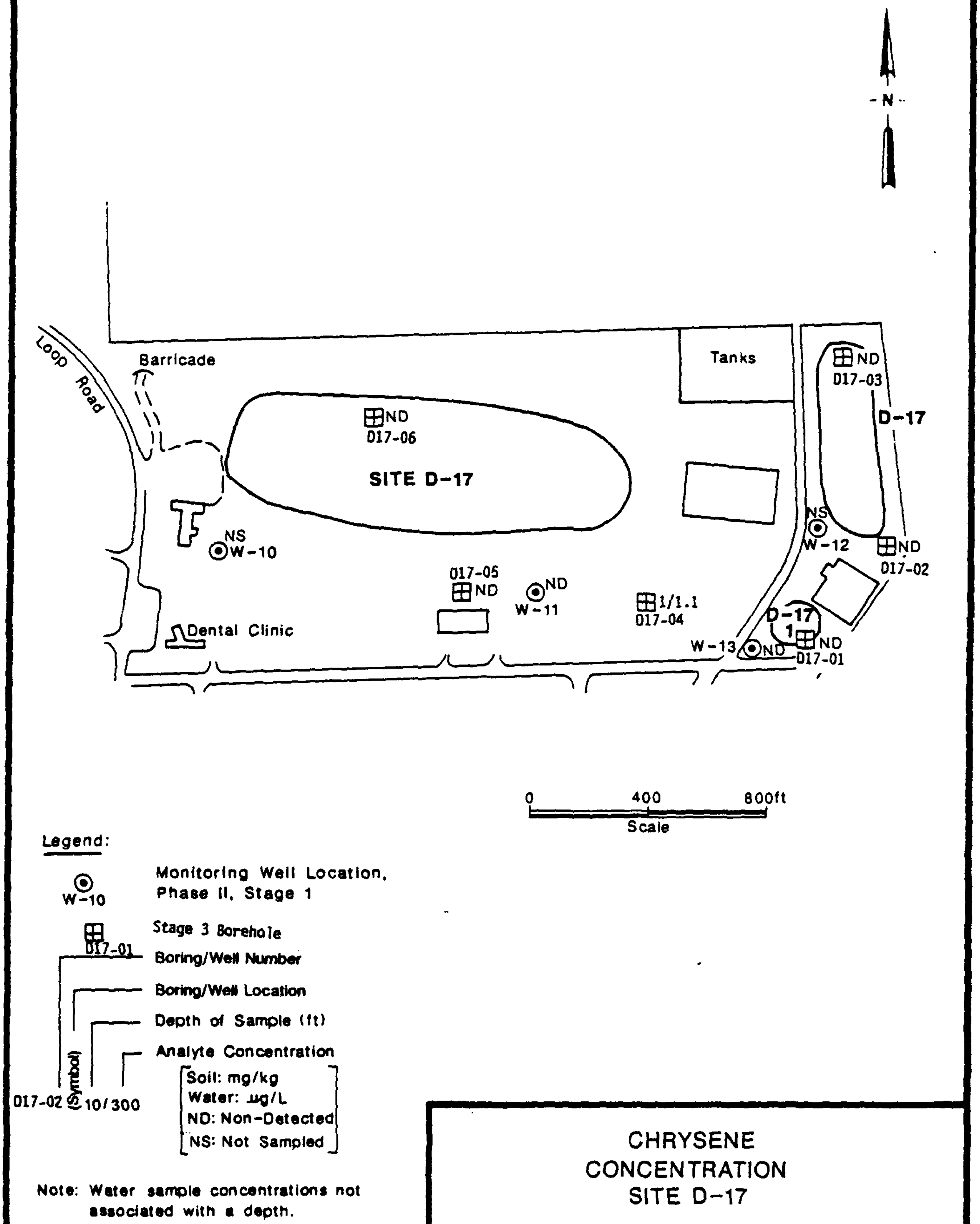
- Soil: mg/kg
- Water: µg/L
- ND: Non-Detected
- NS: Not Sampled

Note: Water sample concentrations not associated with a depth.

BENZO(b)FLUORANTHENE
& BENZO(k)FLUORANTHENE
CONCENTRATION
SITE D-17

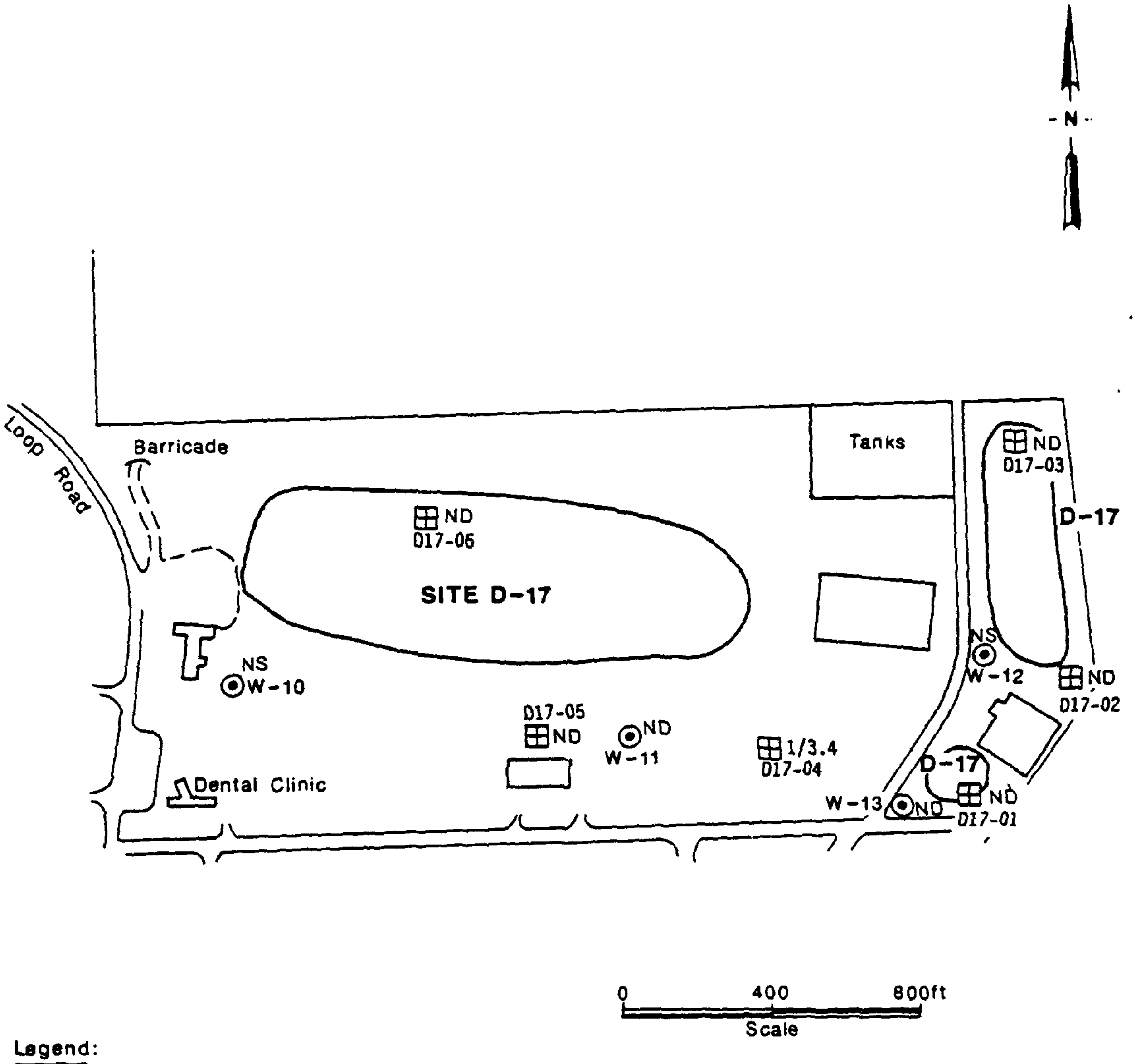
IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.7.11



CHRYSENE
CONCENTRATION
SITE D-17

IRP Stage 3 RI/FS **Elmendorf AFB, AK**	**Figure** 4.2.7.12



Legend:

W-10 Monitoring Well Location, Phase II, Stage 1

D17-05 Stage 3 Borehole

Boring/Well Number

Boring/Well Location

Depth of Sample (ft)

Analyte Concentration

D17-06 (Symbol) 10/300

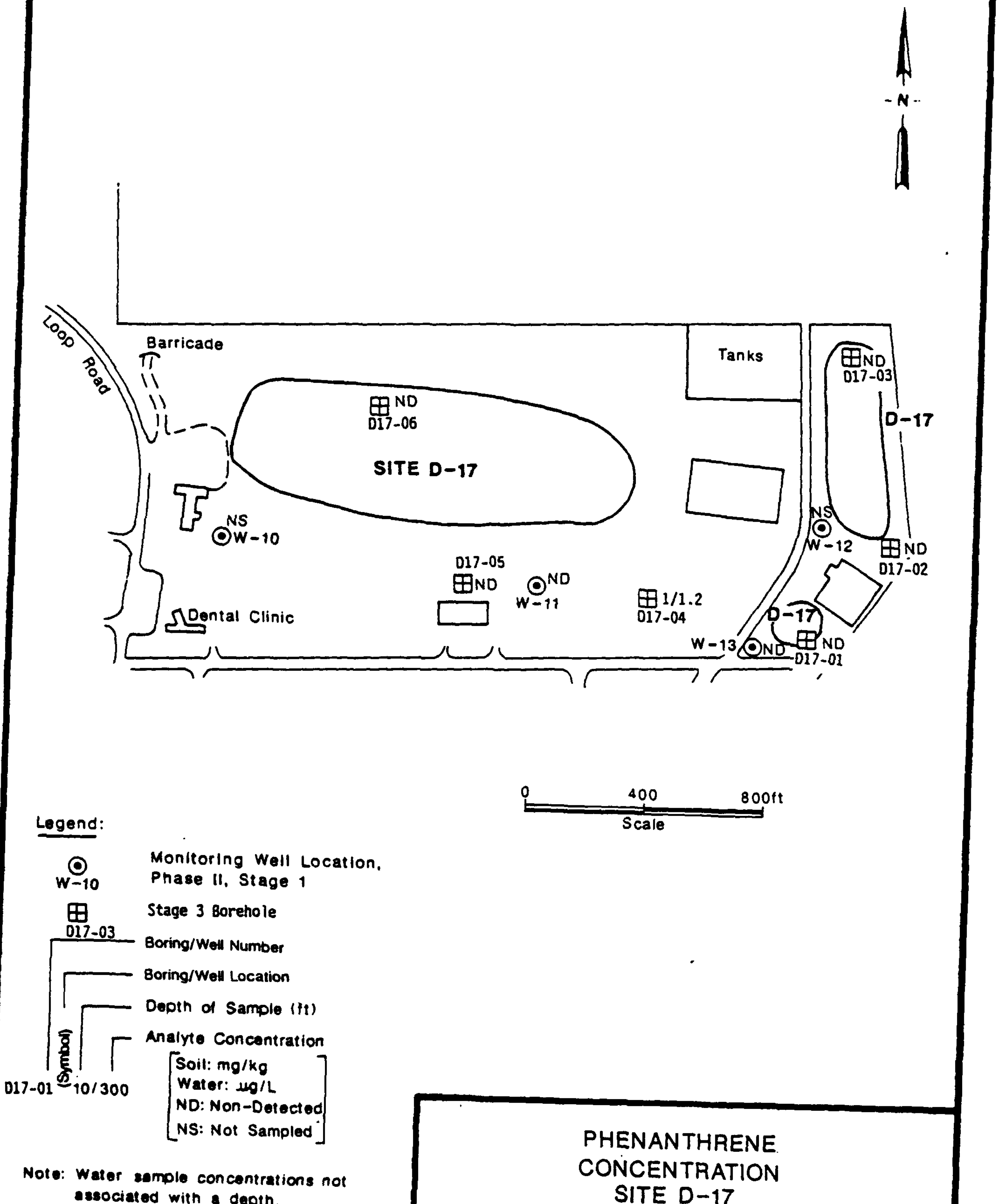
Soil: mg/kg
Water: µg/L
ND: Non-Detected
NS: Not Sampled

Note: Water sample concentrations not associated with a depth.

FLUORANTHENE
CONCENTRATION
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

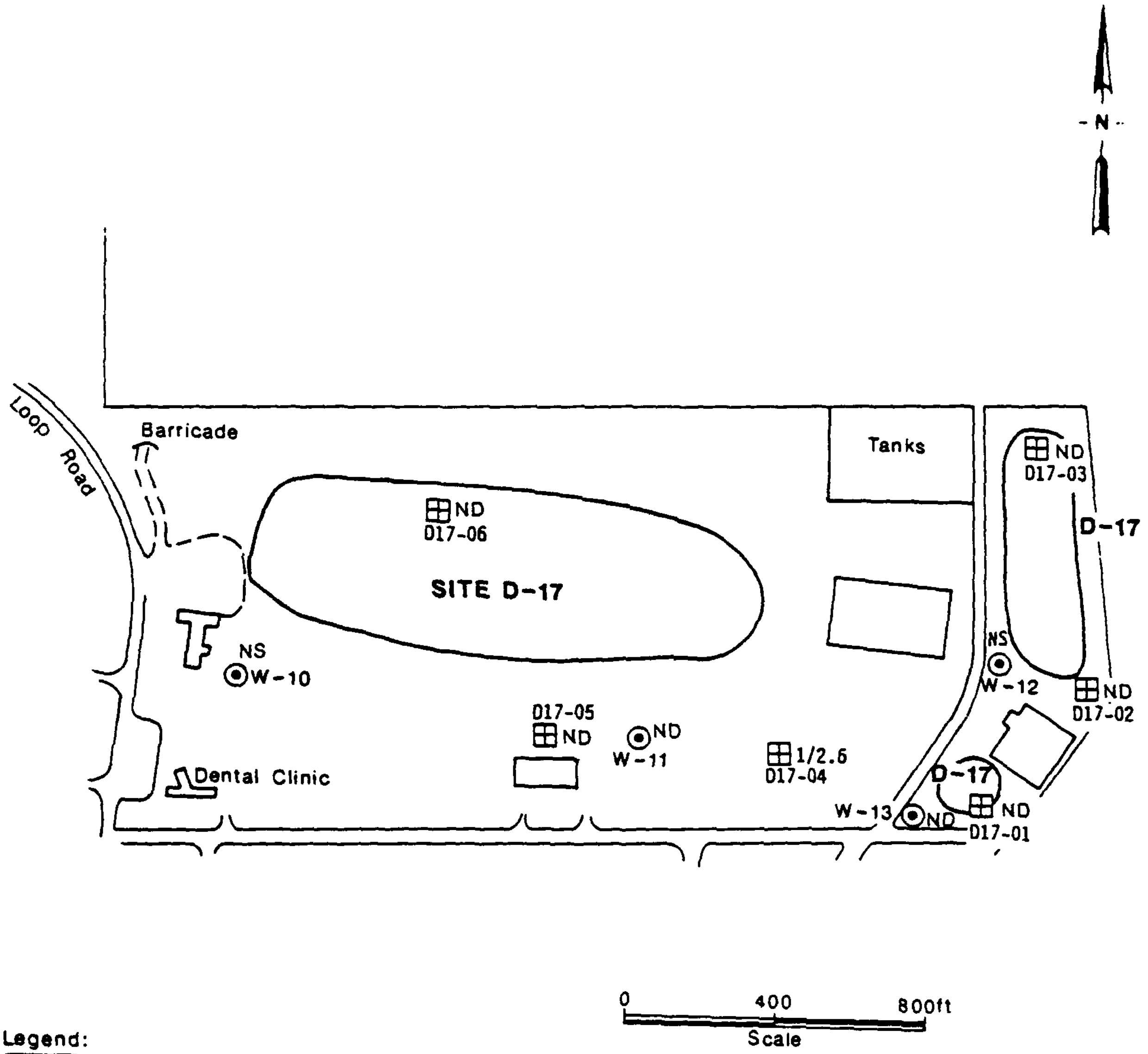
Figure
4.2.7.13



PHENANTHRENE CONCENTRATION SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.7.14



Legend:

- W-10 — Monitoring Well Location, Phase II, Stage 1
- D17-01 — Stage 3 Borehole

D17-04 (Symbol) 10/300

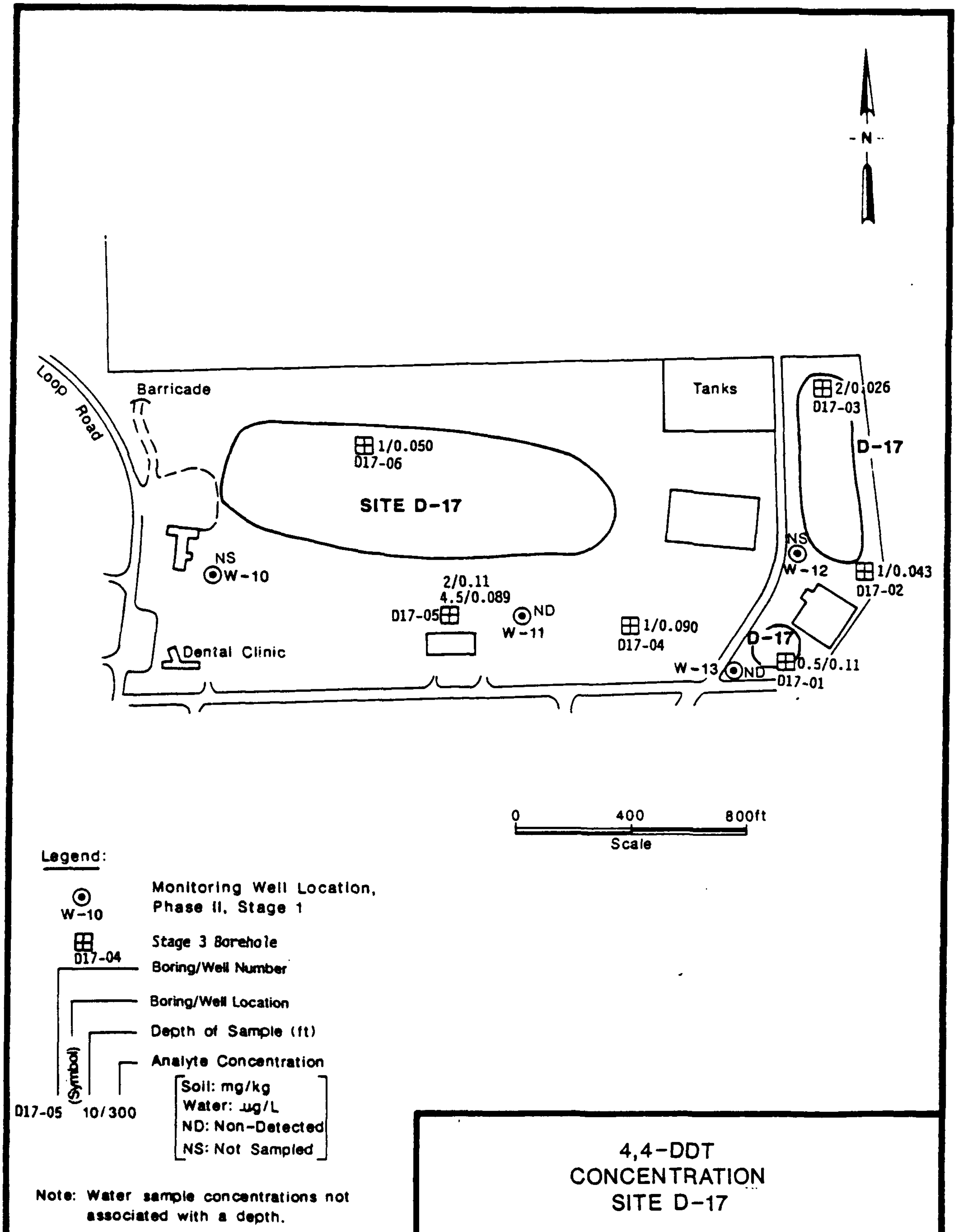
- Boring/Well Number
- Boring/Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: µg/L
  - ND: Non-Detected
  - NS: Not Sampled

Note: Water sample concentrations not associated with a depth.

PYRENE
CONCENTRATION
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

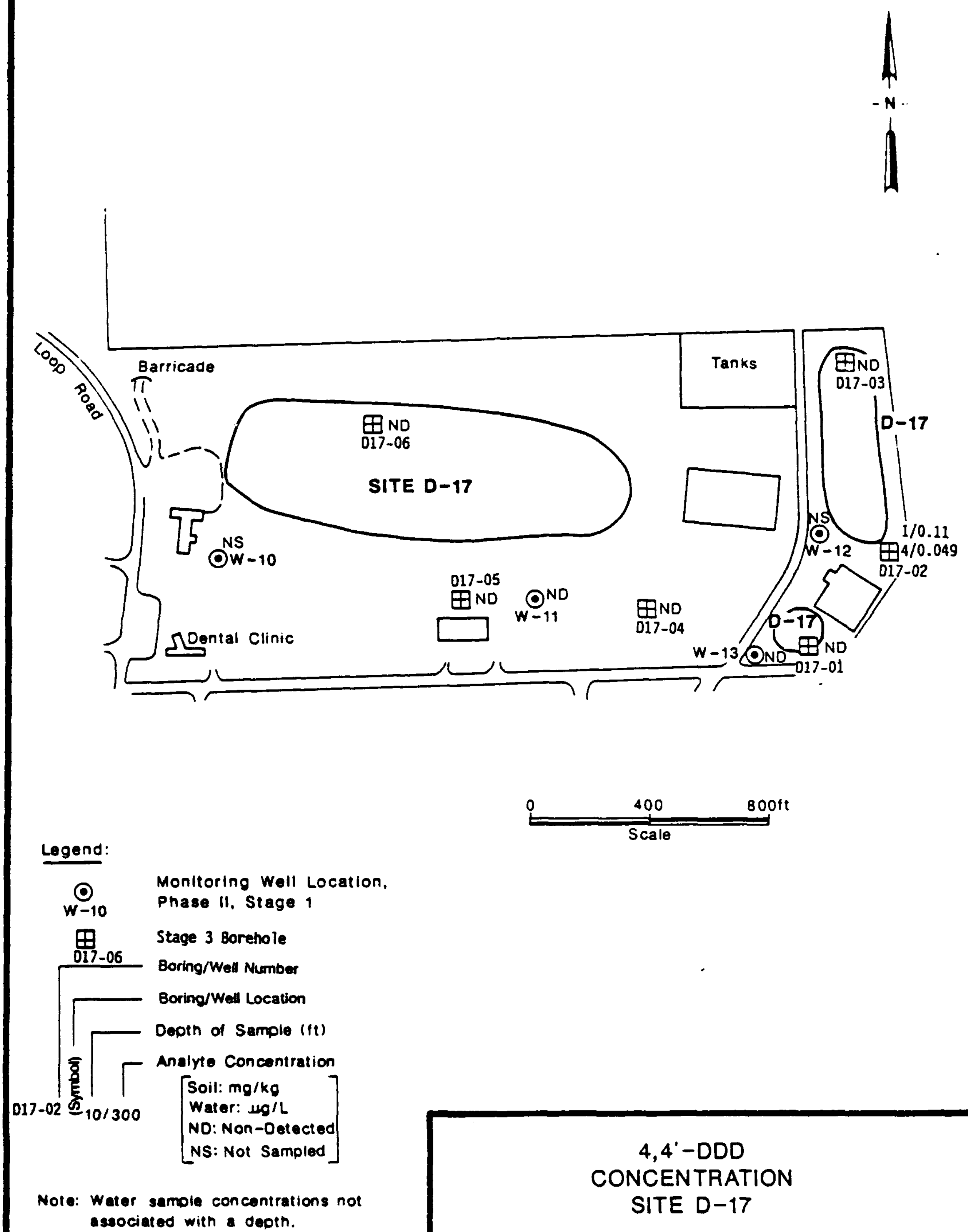
Figure
4.2.7.15



4,4-DDT
CONCENTRATION
SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.7.16



4,4'-DDD CONCENTRATION SITE D-17

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.7.17

Table 4.2.7.4

Analytical Results - Site D-17

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	D17-03 2'-2.5' 0687-SO-027 CS-88-0001 000798-0010	D17-06 1'-2' 0687-SO-030 CS-88-0001 000798-0014	D17-06 4'-5' 0687-SO-030 CS-88-0002 000798-0015	D17-03 4.5'-5' 0687-SO-027 CS-88-0002 000798-0013	D17-05 2'-2.5' 0687-SO-029 CS-88-0001 000827-0001	D17-05 4.5'-5' 0687-SO-029 CS-88-0002 000827-0002
1,2-Dichloroethane	EPA 601	ug/L	5.0						
4,4'-DDD	SW8080	mg/kg							
4,4'-DDT	SW8080	mg/kg	2.06	0.026	0.050			0.11	0.089
Aluminum	6010	mg/kg		16426	17755	15369	15833	13558	13701
Barium	6010	mg/kg		68	86	79	53	41	46
Benzene	EPA 602	ug/L	5.0						
Benzo(a)anthracene	Method 8270	mg/kg							
Benzo(a)pyrene	Method 8270	mg/kg	0.061						
Benzo(b)fluoranthene	Method 8270	mg/kg							
Benzo(k)fluoranthene	Method 8270	mg/kg							
Beryllium	6010	mg/kg		0.3	0.3	0.3	0.3	0.3	0.3
Calcium	6010	mg/kg		3330	3093	3634	5208	4383	4192
Chloride	300.0	mg/L	250						
Chromium	6010	mg/kg	50,000	26	18	31	30	23	28
Chrysene	Method 8270	mg/kg							
Cobalt	6010	mg/kg		10	7	10	11	12	12
Copper	6010	mg/kg	1,850	17	15	19	35	20	26
Dissolved Arsenic	206.2	mg/L	0.05						
Dissolved Barium	200.7	mg/L	1.0						
Dissolved Calcium	200.7	mg/L							
Dissolved Magnesium	200.7	mg/L							
Dissolved Manganese	200.7	mg/L	0.05						
Dissolved Potassium	200.7	mg/L							
Dissolved Sodium	200.7	mg/L	250						
Dissolved Zinc	200.7	mg/L	5.0						
Fluoranthene	Method 8270	mg/kg							
Iron	6010	mg/kg		26193	20160	25545	29063	26300	27505
Lead	6010	mg/kg	70	12	9	7	7	8	7
METHYLENE CHLORIDE	601	ug/L							
Magnesium	6010	mg/kg		7436	3666	7580	11354	8053	9509
Manganese	6010	mg/kg	11,000	588	275	415	667	540	816
Mercury	7471	mg/kg	100	0.10	0.10	0.08	0.07		0.06
Nickel	6010	mg/kg	500	27	15	29	39	27	34
Nitrate as N	300.0	mg/L	10						
OIL & GREASE	413.2	mg/L							
Phenanthrene	Method 8270	mg/kg							
Potassium	6010	mg/kg				675	729		613
Pyrene	Method 8270	mg/kg							
Recoverable Aluminum	200.7	mg/L							
Recoverable Arsenic	206.2	mg/L	0.05						
Recoverable Barium	200.7	mg/L	1.0						
Recoverable Calcium	200.7	mg/L							
Recoverable Chromium	200.7	mg/L	0.05						
Recoverable Cobalt	200.7	mg/L							
Recoverable Copper	200.7	mg/L	1.0						
Recoverable Iron	200.7	mg/L	0.3						
Recoverable Lead	239.2	mg/L	0.05						
Recoverable Magnesium	200.7	mg/L							
Recoverable Manganese	200.7	mg/L	0.05						
Recoverable Molybdenum	200.7	mg/L							
Recoverable Nickel	200.7	mg/L							
Recoverable Potassium	200.7	mg/L							
Recoverable Sodium	200.7	mg/L	250						
Recoverable Vanadium	200.7	mg/L							
Recoverable Zinc	200.7	mg/L	5.0						
Sodium	6010	mg/kg		89	137	104	125	82	102
Sulfate	300.0	mg/L	250						
TETRACHLOROETHENE	601	ug/L	5.0						
TOC	415.1	mg/L							
TOX	9020	ug/L							
TRANS-1,2-DICHLOROETHENE	601	ug/L							
TRICHLOROETHENE (TCE)	601	ug/L	5.0						
TRICHLOROFLUOROMETHANE	601	ug/L							
Total Dissolved Solids	160.1	mg/L	500						
Total Mercury	245.1	mg/L	0.002						
Total Petroleum Hydrocarbons	EPA 418.1			67					
Total Solids	160.3	%		90.1	87.3	96.3	96.0	98.1	97.8
Trichloroethene	EPA 601	ug/L	5.0						
Vanadium	6010	mg/kg	1,000	51	48	49	56	47	46
Zinc	6010	mg/kg	10,500	55	33	50	58	53	53

Table 4.2.7.4

Analytical Results - Site D-17

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-11 GN840281	W-11 0687-NG-031 001347-0002 GN-88-0001	W-11 W-11/11	D17-04 1'-2' 0687-SO-028 000798-0011 CS-88-0001	D17-04 4'-5' 0687-SO-028 000798-0012 CS-88-0002	D17-02 1'-2' 0687-SO-026 000798-0008 CS-88-0001
1,2-Dichloroethane	EPA 601	ug/L	5.0						
4,4'-DDD	SW8080	mg/kg							0.11
4,4'-DDT	SW8080	mg/kg	2.06				0.090		0.043
Aluminum	6010	mg/kg					17189	11307	14861
Barium	6010	mg/kg					227	80	64
Benzene	EPA 602	ug/L	5.0		1.3				
Benzo(a)anthracene	Method 8270	mg/kg					1.1		
Benzo(a)pyrene	Method 8270	mg/kg	0.061				0.92		
Benzo(b)fluoranthene	Method 8270	mg/kg					1.1		
Benzo(k)fluoranthene	Method 8270	mg/kg					1.1		
Beryllium	6010	mg/kg					0.4	0.2	0.3
Calcium	6010	mg/kg					5405	4149	3922
Chloride	300.0	mg/L	250		9.0				
Chromium	6010	mg/kg	50,000				30	23	31
Chrysene	Method 8270	mg/kg					1.1		
Cobalt	6010	mg/kg					9	9	11
Copper	6010	mg/kg	1,850				22	22	27
Dissolved Arsenic	206.2	mg/L	0.05		0.020				
Dissolved Barium	200.7	mg/L	1.0		0.20				
Dissolved Calcium	200.7	mg/L			58.				
Dissolved Magnesium	200.7	mg/L			18.				
Dissolved Manganese	200.7	mg/L	0.05		2.7				
Dissolved Potassium	200.7	mg/L			7.				
Dissolved Sodium	200.7	mg/L	250		16.				
Dissolved Zinc	200.7	mg/L	5.0		0.04				
Fluoranthene	Method 8270	mg/kg					3.4		
Iron	6010	mg/kg					23892	21888	26006
Lead	6010	mg/kg	70				29	15	39
METHYLENE CHLORIDE	601	ug/L				3.7			
Magnesium	6010	mg/kg					6811	6846	9082
Manganese	6010	mg/kg	11,000				497	446	660
Mercury	7471	mg/kg	100				0.11	0.11	0.06
Nickel	6010	mg/kg	500				23	24	31
Nitrate as N	300.0	mg/L	10						
OIL & GREASE	413.2	mg/L		3.1					
Phenanthrene	Method 8270	mg/kg					1.2		
Potassium	6010	mg/kg							568
Pyrene	Method 8270	mg/kg					2.6		
Recoverable Aluminum	200.7	mg/L			17.				
Recoverable Arsenic	206.2	mg/L	0.05		0.015				
Recoverable Barium	200.7	mg/L	1.0		0.39				
Recoverable Calcium	200.7	mg/L			86.				
Recoverable Chromium	200.7	mg/L	0.05		0.03				
Recoverable Cobalt	200.7	mg/L			0.02				
Recoverable Copper	200.7	mg/L	1.0		0.10				
Recoverable Iron	200.7	mg/L	0.3		38.				
Recoverable Lead	239.2	mg/L	0.05		0.12				
Recoverable Magnesium	200.7	mg/L			24.				
Recoverable Manganese	200.7	mg/L	0.05		4.6				
Recoverable Molybdenum	200.7	mg/L							
Recoverable Nickel	200.7	mg/L			0.04				
Recoverable Potassium	200.7	mg/L			8.				
Recoverable Sodium	200.7	mg/L	250		13.				
Recoverable Vanadium	200.7	mg/L			0.07				
Recoverable Zinc	200.7	mg/L	5.0		0.10				
Sodium	6010	mg/kg					162	145	93
Sulfate	300.0	mg/L	250		13.				
TETRACHLOROETHENE	601	ug/L	5.0						
TOC	415.1	mg/L		5					
TOX	9020	ug/L		110					
TRANS-1,2-DICHLOROETHENE	601	ug/L				16			
TRICHLOROETHENE (TCE)	601	ug/L	5.0			47			
TRICHLOROFLUOROMETHANE	601	ug/L				0.62			
Total Dissolved Solids	160.1	mg/L	500	380					
Total Mercury	245.1	mg/L	0.002		0.0004				
Total Petroleum Hydrocarbons	EPA 418.1				2.0		65		144
Total Solids	160.3	%					92.5	96.4	96.9
Trichloroethene	EPA 601	ug/L	5.0		45.				
Vanadium	6010	mg/kg	1,000				57	39	50
Zinc	6010	mg/kg	10,500				54	47	63

Table 4.2.7.4

Analytical Results - Site D-17

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	D17-02 4'-5' 0687-SO-026 CS-88-0002 000798-0009	W-13 0687-MG-032 GN-88-0001 001347-0001	W-13 DUPLICATE 0687-MG-032 GN-88-0001D 001347-0001	W-13 GN840283	W-13 W-13/10	D17-01 4'-5' 0687-SO-025 CS-88-0002 000798-0007	W-10 GN840280	W-10 W-10/12	W-12 W-12/9	W-12 GN8402
1,2-Dichloroethane	EPA 601	ug/L	5.0		0.57	0.64		1.1					
4,4'-DDD	SW8080	mg/kg		0.049									
4,4'-DDT	SW8080	mg/kg	2.06										
Aluminum	6010	mg/kg		15567					13728				
Barium	6010	mg/kg		52					61				
Benzene	EPA 602	ug/L	5.0										
Benzo(a)anthracene	Method 8270	mg/kg											
Benzo(a)pyrene	Method 8270	mg/kg	0.061										
Benzo(b)fluoranthene	Method 8270	mg/kg											
Benzo(k)fluoranthene	Method 8270	mg/kg											
Beryllium	6010	mg/kg		0.3					0.2				
Calcium	6010	mg/kg		5154					5069				
Chloride	300.0	mg/L	250		10.	10.							
Chromium	6010	mg/kg	50,000	29					25				
Chrysene	Method 8270	mg/kg											
Cobalt	6010	mg/kg		10					12				
Copper	6010	mg/kg	1,850	26					21				
Dissolved Arsenic	206.2	mg/L	0.05		0.004	0.004							
Dissolved Barium	200.7	mg/L	1.0		0.15	0.10							
Dissolved Calcium	200.7	mg/L			105.	104.							
Dissolved Magnesium	200.7	mg/L			26.	26.							
Dissolved Manganese	200.7	mg/L	0.05		4.9	5.0							
Dissolved Potassium	200.7	mg/L			7.	7.							
Dissolved Sodium	200.7	mg/L	250		21.	16.							
Dissolved Zinc	200.7	mg/L	5.0		0.04	0.02							
Fluoranthene	Method 8270	mg/kg											
Iron	6010	mg/kg		26289					25026				
Lead	6010	mg/kg	70	21					24				
METHYLENE CHLORIDE	601	ug/L									19	6.3	
Magnesium	6010	mg/kg		9278					9081				
Manganese	6010	mg/kg	11,000	650					602				
Mercury	7471	mg/kg	100	0.08									
Nickel	6010	mg/kg	500	29					27				
Nitrate as N	300.0	mg/L	10			0.6							
OIL & GREASE	413.2	mg/L					2.7			1.2			1
Phenanthrene	Method 8270	mg/kg											
Potassium	6010	mg/kg		588									
Pyrene	Method 8270	mg/kg											
Recoverable Aluminum	200.7	mg/L			17.	21.							
Recoverable Arsenic	206.2	mg/L	0.05		0.007	0.007							
Recoverable Barium	200.7	mg/L	1.0		0.19	0.20							
Recoverable Calcium	200.7	mg/L			109.	110.							
Recoverable Chromium	200.7	mg/L	0.05		0.03	0.05							
Recoverable Cobalt	200.7	mg/L			0.02	0.02							
Recoverable Copper	200.7	mg/L	1.0		0.067	0.066							
Recoverable Iron	200.7	mg/L	0.3		29.	37.							
Recoverable Lead	239.2	mg/L	0.05		0.076	0.076							
Recoverable Magnesium	200.7	mg/L			34.	36.							
Recoverable Manganese	200.7	mg/L	0.05		11.	9.7							
Recoverable Molybdenum	200.7	mg/L			0.04	0.04							
Recoverable Nickel	200.7	mg/L			0.04	0.05							
Recoverable Potassium	200.7	mg/L			7.	8.							
Recoverable Sodium	200.7	mg/L	250		18.	17.							
Recoverable Vanadium	200.7	mg/L			0.05	0.06							
Recoverable Zinc	200.7	mg/L	5.0		0.08	0.09							
Sodium	6010	mg/kg		93					116				
Sulfate	300.0	mg/L	250		31.	30.							
TETRACHLOROETHENE	601	ug/L	5.0									1.6	
TOC	415.1	mg/L					15			3			2
TOX	9020	ug/L					140			77			140
TRANS-1,2-DICHLOROETHENE	601	ug/L						15				30	
TRICHLOROETHENE (TCE)	601	ug/L	5.0					5.2				26	
TRICHLOROFLUOROMETHANE	601	ug/L						0.68					
Total Dissolved Solids	160.1	mg/L	500			540.	260			360			380
Total Mercury	245.1	mg/L	0.002		0.0002	0.0002							
Total Petroleum Hydrocarbons	EPA 418.1				2.0	1.0							
Total Solids	160.3	%		97.0					94.7				
Trichloroethene	EPA 601	ug/L	5.0		5.4	5.5							
Vanadium	6010	mg/kg	1,000	53					48				
Zinc	6010	mg/kg	10,500	59					59				

4.2.7.1.5 Discussion of Analytical Data

Contamination by organic compounds was prevalent at Site D-17. Concentrations were generally low and were limited to boreholes and wells situated to the east. For example, benzene (1.3 ug/L) was only detected in a water sample from well W-11; total petroleum hydrocarbons (2.0 mg/L) were also detected in this sample. Total petroleum hydrocarbons (2.0 mg/L) were also detected in a water sample taken from well W-13. However, total petroleum hydrocarbons were more prevalent in soil samples from the site. Total petroleum hydrocarbons were detected in surface soil samples from boreholes D17-01, D17-02, D17-03 and D17-04 at concentrations of 160, 140, 67, and 65 mg/kg, respectively.

Chlorinated hydrocarbon compounds were detected in water samples from two of the wells sampled at Site D-17. Trichloroethene was detected at concentrations of 45 and 5.4 ug/L in wells W-11 and W-13, respectively. A water sample from well W-13 contained 1,2-dichloroethane at a concentration of 0.57 ug/L. The following polycyclic aromatic hydrocarbons (PAH) were detected only in the surface soil sample from borehole D17-04: benzo(a)anthracene (1.1 mg/kg), benzo(a)pyrene (0.92 mg/kg), benzo(b)fluoranthene (1.1 mg/kg), benzo(k)fluoranthene (1.1 mg/kg), chrysene (1.1 mg/kg), fluoranthene (3.4 mg/kg), phenanthrene (1.2 mg/kg), and pyrene (2.6 mg/kg).

Organochlorine pesticides were detected in soil from several boreholes at Site D-17 (Figures 4.2.7.16 and 4.2.7.17). The compound 4,4'-DDT was detected in all 6 boreholes at concentrations ranging from 0.026 mg/kg in borehole D17-03 to 0.11 mg/kg in borehole D17-05.

Metals such as aluminum (11,300 to 17,200 mg/kg), iron (20,200 to 29,100 mg/kg), manganese (270 to 820 mg/kg) and magnesium (3,700 to 11,400 mg/kg) were detected in soil samples from the site at levels

similar to background concentrations. Water samples also contained these total recoverable concentrations of these metals as high as 17, 38, 11 and 34 mg/L, respectively. These concentrations are related to the natural distribution of minerals in the soils of the area. No dissolved aluminum or iron was detected. Maximum concentrations of dissolved manganese and magnesium were 4.9 and 26 mg/L, respectively. High calcium levels in soil (3100 to 5400 mg/kg) and water samples (109 and 86 mg/L, total recoverable; 105 and 58 mg/L, dissolved), sodium levels in soil (82 to 160 mg/kg) and water samples (13 and 18 mg/L, total recoverable; 16 and 21 mg/L, dissolved), and potassium levels in soil (560 to 750 mg/kg) and water samples (8 mg/L, total; 7 mg/L dissolved) are also due to the natural mineral content of the surrounding soils.

Sulfate and chloride ions were detected in water samples at concentrations of 13 and 31 mg/L and 9 and 10 mg/L, respectively.

Small amounts of other elements such as barium (41 to 230 mg/kg), chromium (18 to 31 mg/kg), cobalt (6.9 to 12 mg/kg), copper (17 to 35 mg/kg), lead (7 to 39 mg/kg) nickel (15 to 39 mg/kg), vanadium (39 to 57 mg/kg), and zinc (33 to 63 mg/kg) were detected in soil samples from all borings. Water samples from wells W-11 and W-13 contained total recoverable barium at concentrations of 0.39 and 0.19 mg/L, respectively and dissolved barium at concentrations of 0.20 and 0.15 mg/L, respectively. All of the remaining elements delineated above were detected in total recoverable form in both water samples at concentrations less than 0.1 mg/L. In addition, molybdenum was detected at a concentration of 0.04 mg/L in the water sample from well W-13. Dissolved zinc was detected at a concentration of 0.04 mg/L in each well. Dissolved chromium, cobalt, copper, lead, nickel and vanadium were not detected in water samples from either well.

Trace amounts of mercury (0.11 mg/kg or less) and beryllium (0.4 mg/kg or less) were detected in soil samples from all test borings at Site

D-17. Water samples from both wells contained trace amounts of total mercury (0.0004 mg/L or less) and total and dissolved arsenic (0.02 mg/L or less).

4.2.7.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site D-17 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.7.2.1 Loss of Samples

No soil or water samples collected for laboratory analyses were lost from Site D-17.

4.2.7.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results.

4.2.7.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Twelve soil samples were collected from 6 shallow borings and 2 water samples were collected from previously existing wells at Site D-17. No out-of-control conditions occurred during drilling or water sampling operations at the site.

4.2.7.3 Significance of Findings

Analytical results for soil and water samples from Site D-17 showed contamination by various organic compounds. Concentrations of trichloroethene, detected in water samples from wells W-11 and W-13 at the site, exceed its current MCL of 5 ug/L. Benzo (a) pyrene exceeds the calculated soil cleanup level of 0.12 mg/kg which is based on a 10^{-6} cancer risk. In addition, TPH concentrations are above the interim State of Alaska cleanup guidelines levels of 100 mg/kg. Samples collected from wells W-11 and W-13 drilled in 1986 by Dames and Moore (1987) were contaminated with trichloroethene at concentrations above the State of Alaska drinking water standards of 5 ug/L. Trans-1,2-dichloroethene was also detected in the wells; this compound is not regulated by state or federal standards.

The source of these contaminants in the groundwater is shop wastes poured directly into a trench (Engineering Science, 1983). Basic receptors are humans, wildlife, and plants. Pathways of exposure to the receptors of these contaminants include ingestion of groundwater by humans and wildlife, and uptake of groundwater by plants.

4.2.7.3.1 Zones of Contamination

Although the actual location of the trench is not known, the data density at the site allows for some generalization of the zones of contamination. Well W-11, which is near Site D-17, was contaminated with benzene and trichloroethene at concentrations of 1.3 and 45 ug/L, respectively. A 1986 water sample from this well also contained trichloroethene at a concentration of 47 ug/L. Well W-13 is located southeast of well W-11 and possibly outside of the site. Well W-13 contained trichloroethene at a level of 5.4 ug/L. A 1986 sample from this well contained trichloroethene at a concentration of 5.2 ug/L. Well W-13 also contained 1,2-dichloroethane below its MCL. Well W-13

is not situated directly downgradient from another sampling point at Site D-17. Buildings 32-140 and 32-141, located near boring D17-01 and well W-13, are used as a maintenance shop for heavy equipment. Prior to the early 1970's, the wastes generated in the shop were disposed of in a dry well outside the shop. The contaminants detected in surveys are probably associated with this waste disposal practice.

A soil gas survey at Site D-17 showed several specific zones of contamination: 1) upgradient of well W-11, 2) crossgradient from well W-13 and, 3) upgradient of well W-12 (Figure 4.2.7.3, Table 4.2.7.1). Laboratory analysis of soil samples confirmed the presence of petroleum hydrocarbons in 4 of the borings located generally on the eastern half of the site (test borings D17-01 through D17-04). Contamination by petroleum hydrocarbons was not detected in soil from boreholes D17-05 and D17-06. However, the pesticide 4,4'-DDT was detected in surface soils at these boreholes. General isoconcentration lines have been constructed for the soil gas data, but there is insufficient data from other sources to allow three-dimensional temporal or higher-definition spatial mapping.

4.2.7.3.2 Contaminant Migration

The primary migration medium at Site D-17 is groundwater. A clear pattern of contamination along the groundwater gradient is not evident since only 2 wells were sampled. These wells, wells W-11 and W-13, are situated crossgradient from each other. However, they are contaminated by several similar contaminants, although well W-13 contains lower concentrations. The relationship of the location of these wells to the contaminant source location and site boundaries has not been clearly shown.

Vapor-phase migration was identified by the soil gas survey. But since the soil gas survey did not extend offsite, results cannot be

used to delineate offsite migration of the BTX and unidentified organic contamination.

4.2.7.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off-Base migration at Site D-17 is unknown. Records suggest that well W-13 may be outside and downgradient of the site boundary, but the actual contaminant source location is not known. Water samples from well W-13 are contaminated with organic compounds above State of Alaska water quality standards. Soil samples from borings suspected to be outside of the site boundaries did not reach the water table and therefore cannot be used to predict contamination migration in the saturated zone.

4.2.7.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site identified the direction of groundwater flow to be to the south, with a gradient of about 50 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of migration rates.

4.2.7.3.2.3 Time of Travel to Receptors

Primary receptors are humans, plants, and wildlife. Even though offsite migration of contamination has not been shown by this study, the primary pathway would be through contaminated groundwater. A

downgradient active well, base well 2 (BW-2), is located about 4500 feet from Site D-17 at building 22-001. Hydraulic conductivity values have not been fully established at this site; thus, time of travel to the well cannot be determined. Well BW-2, an artesian well, was sampled as part of this study. Samples collected from the well did not indicate organic contamination. Results of the sample analyses are included in Section 4.2.24.

Another pathway to receptors may be through the ingestion or uptake of contaminated surface water. Water tends to pond in depressed areas at the site. Contamination from surface soils may enter the ponded water. Time of travel to receptors from this source is negligible. In addition, plants may uptake contaminated groundwater. Again time of travel is negligible.

4.2.7.3.2.4 Expected Spatial and Temporal Variations in Concentration

Groundwater flow is primarily to the south beneath Site D-17. The spacial extent of contamination past the site boundaries is unknown, since no downgradient wells exist that are clearly offsite. Well W-13 is contaminated, but the contamination may or may not extend to the south, past this well. Ponded surface water is unlikely to travel offsite due to the flat surface gradient.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of metals is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.7.3.3 Baseline Risk Assessment

The contamination detected at the site in relationship to receptors, pathways of exposure, and anticipated adverse effects are characterized in the following sections.

4.2.7.3.3.1 Waste Characterization

The primary wastes at this site are organic compounds. Benzene is a component of fuels and is classified as a human carcinogen. Trichloroethene is used as a solvent and paint thinner; it is a suspected human carcinogen. 1,2-dichloroethane is a solvent used for removal of oils and grease; it is a suspected human carcinogen. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(b) fluoranthene, chrysene, fluoranthene, phenanthrene, and pyrene are all polycyclic aromatic hydrocarbons (PAH) associated with coal tar; many are also found in gasolines and motor oil. They are suspected human carcinogens.

The pesticides 4,4'-DDT and 4,4'-DDD were detected in several soil samples. These chemicals affect the central nervous system, are stored in fatty deposits, may be carcinogenic and are nondegradable.

4.2.7.3.3.2 Source and Release Characterization

Shop wastes poured into a trench constitute the source of organic contamination at the site. The exact location of the trench is unknown (Engineering-Science, 1983).
The scope of this study does not allow an accurate estimate of the volume of contamination released since exact types and quantities of materials dumped at the site were never recorded. However, the site was used as a shop waste disposal area for about 10 years. Several of the presently active shops on base use about 55-gallons of solvents a month. Assuming this figure is representative for past shop work, and also assuming that the waste from only 1 shop was disposed of at Site D-17, a volume of about 660 gallons of material a year would have been deposited in the trench.

4.2.7.3.3.3 Fate and Transport of Contaminants

The fate of organic chemicals released to the environment at Site D-17 includes long-term natural degradation, dispersion of the contaminants through runoff or groundwater, or uptake by living organisms. Another possible fate is the volatilization of compounds that have vapor pressures (v.p.) greater than 1 mm mercury (v.p. of benzene is 100 mm at 26 C, v.p. of trichloroethene is 100 mm at 20 C). Pesticides are particularly environmentally persistent and are considered nondegradable.

Evidence of migration of organic compounds is not readily apparent at the site. However, well W-13 appears to be located offsite and was found to be contaminated. The actual transport rate, plume dimensions and precise direction of contamination migration are not known for this site.

4.2.7.3.3.4 Exposure Pathways

The primary pathways of exposure are ingestion of or contact with contaminated ground or surface water, plants or wildlife.

4.2.7.3.3.5 Identification of Receptors

Human receptors include anyone drinking from the active well down-gradient from the site (base well 2), if it should become contaminated.

Other receptors are any human or animal coming in contact with ponded surface water that may also be contaminated. Wildlife may be exposed through the ingestion of plants contaminated by the groundwater.

4.2.7.3.3.6 Threat to Human Health

The most significant threat to human health is the drinking of water from base well 2, should it become contaminated.

4.2.7.3.3.7 Carcinogenic Risks

Benzo (a) anthracene, benzo (a) pyrene, benzo (b) fluoranthene, benzo (k) fluoranthene, chrysene, fluoranthene, phenanthrene and pyrene were detected in shallow soil samples at the site. These compounds are constituents of coal tars or products of incomplete combustion of heavy oil, waxes or crude oil. They are often found in fuels and motor oils. Toxicity data is not available for each of the compounds mentioned above. However, several of the compounds are either suspected animal carcinogens or known human carcinogens. Soil concentration data indicates that these compounds are at concentrations below what is required for toxic affects to occur by direct uptake in receptions.

The pesticides 4,4'-DDT and 4,4'-DDD were detected in surface soil samples from several boreholes. These compounds are suspected human carcinogens, but their concentrations in soils are not regulated.

4.2.7.3.3.8 Threat to Wildlife

The primary area in which wildlife could be exposed is near well W-11 where water commonly ponds. The ponded water may contain surface contamination. Wildlife also may be exposed through the ingestion of contaminated plants.

4.2.7.4 Prioritization of Sites for Remedial Alternatives

The presence of a downgradient drinking water well and the tendency for surface runoff to accumulate support the need for further investigation. Site D-17 is assigned a medium priority for remedial

alternatives because contaminant exceeded State of Alaska water quality regulations, and the unknown contaminant plume dimensions. Further work at this site should include a soil gas survey in the area downgradient and offsite of Site D-17. The soil gas survey is recommended to aid in selecting locations for 7 additional monitoring wells. One well should be located upgradient of the site, and 6 wells should be located outside the southern and eastern site boundaries. One of the new wells, near existing well W-13, should be screened in the deeper region of the aquifer to delineate the vertical extent of contamination. One of the new downgradient wells should be a dual completion well, screened in the upper and lower regions of the unconfined aquifer. Groundwater from the proposed wells and the 4 existing wells should be sampled and analyzed for TPH, VOCs, extractable priority pollutants, and metals including lead. A minimum of 2 soil samples should be collected from each of the proposed borings and tested for TPH, VOCs, semi-volatile organic compounds, and metals including lead.

4.2.8 Results for Sites IS-1 through IS-8, Hangar Floor Drains

Sites IS-1 through IS-4 and Site IS-6 are active maintenance hangars of similar physical layout and age. Longitudinal floor drains run parallel to the main hangar door in all 5 hangars. The floor drains in each hangar used to incorporate dry wells as part of the floor drain system (Engineering-Science, 1983). At Site IS-1, the floor drains now discharge to 2 oil/water separators. At Site IS-2 and IS-3, there is nothing to suggest that the floor drains do not continue to discharge to the dry wells. At Site IS-4, the floor drains discharge to an oil/water separator and then to the storm drain. At Site IS-6, floor drains appear to discharge to a septic tank and then leach pits east of the building (personal communications, Major T.A. Ritz, 08 March 1989).

Site IS-5 is a garage complex presently used for storage. Floor drains, which used to discharge to dry wells, are connected to a septic tank and leach fields at the south side of the building (personal communications, Major T.A. Ritz, 08 March 1989). Access was restricted to 3 of the 9 bays. No floor drains were observed in any of the bays where access was available and no dry well was evident. A 3-foot diameter concrete drainage pit was located adjacent to the north side of the building.

Site IS-7 is a motorpool maintenance garage with an extensive network of floor drains associated with the service area. These drains also used to discharge to dry wells. Currently, they are piped into 2 concrete sumps, each 3 feet by 6 feet, located inside the building along the rear wall. The sumps discharge to the storm drains. The floor drains from the mechanical room discharge to a seepage pit south of the building (personal communications, Major T.A. Ritz, 08 March 1989).

Site IS-8 is a hangar presently used for general storage and workshop space. Four floor drains are located on the main floor. These drains are piped into a drainpipe network that runs within a utility duct around the exterior of the building. Drainage is routed into a floor drain which is located in the southwest quadrant of the building and then into a dry well.

Additional information including locations and past functions of the floor drain sampling Sites IS-1 through IS-8 is listed below (Figures 4.2.8.1 through 4.2.8.3).

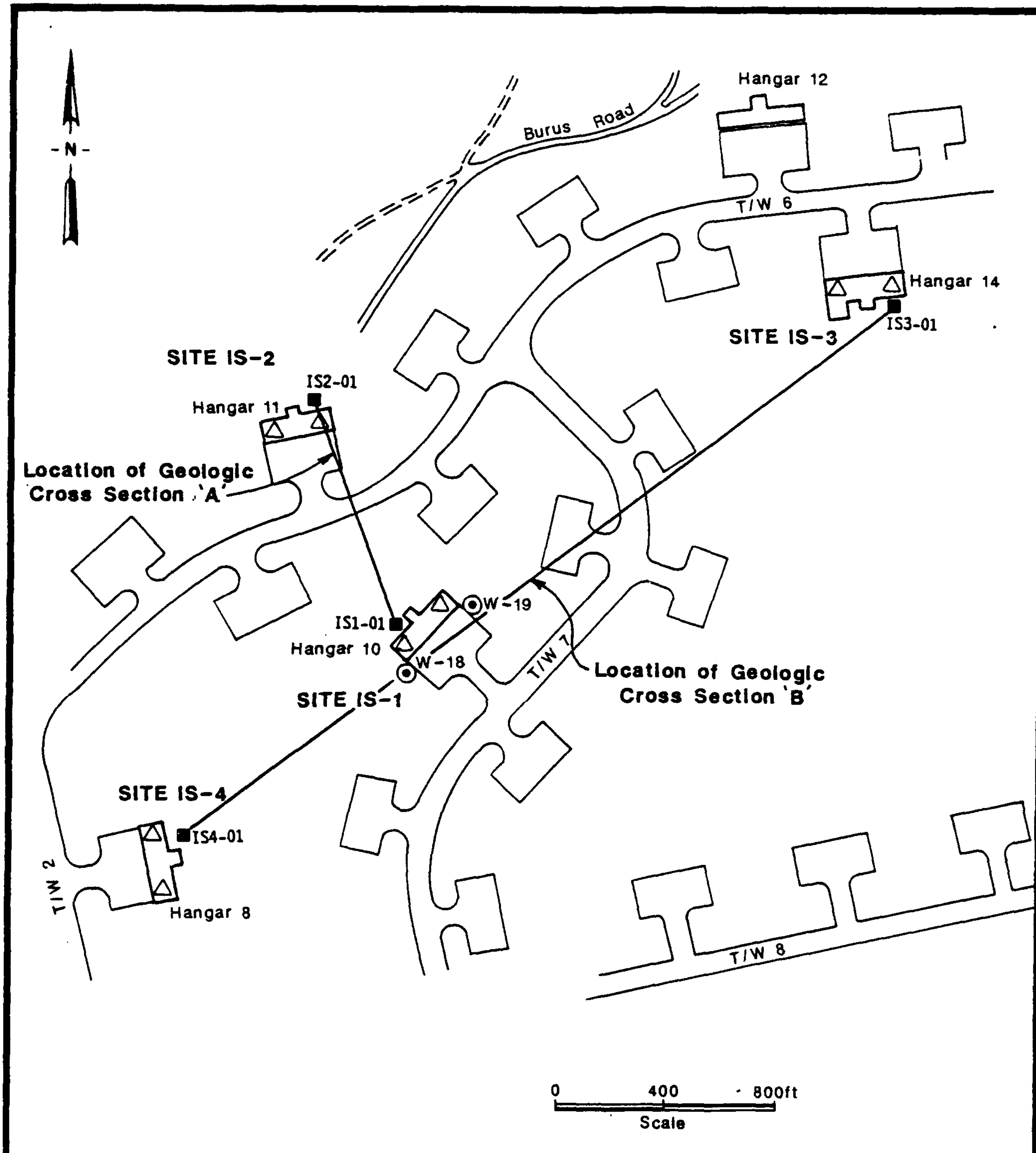
Site IS-1 (located at hangar 10): Hangar 10 is used for fuel loading operations. Numerous spills, 1 of which was as high as 1300 gallons, have occurred at this facility.

Site IS-2 (located at hangar 11): This hangar is used for aircraft maintenance. Approximately 100 gallons per month of the solvent PD-680 is reportedly washed into building floor drains.

Site IS-3 (located at hangar 14): This building is used for helicopter maintenance and contains a helicopter washrack. Reportedly, about 55 gallons per month of PD-680 is used in wash operations; some of this solvent is washed into floor drains (Engineering-Science, 1983).

Site IS-4 (located at hangar 8): Hangar 8 has been the site of aircraft cleaning and painting. It is possible that the floor drains in the building have received rinse water and minor spillage from these operations.

Site IS-5 (located near building 43-410): This site is used for refueling operations, and the building contains a washrack for ground equipment. It has been reported that approximately 55 gallons per month of PD-680 is used in the washrack.

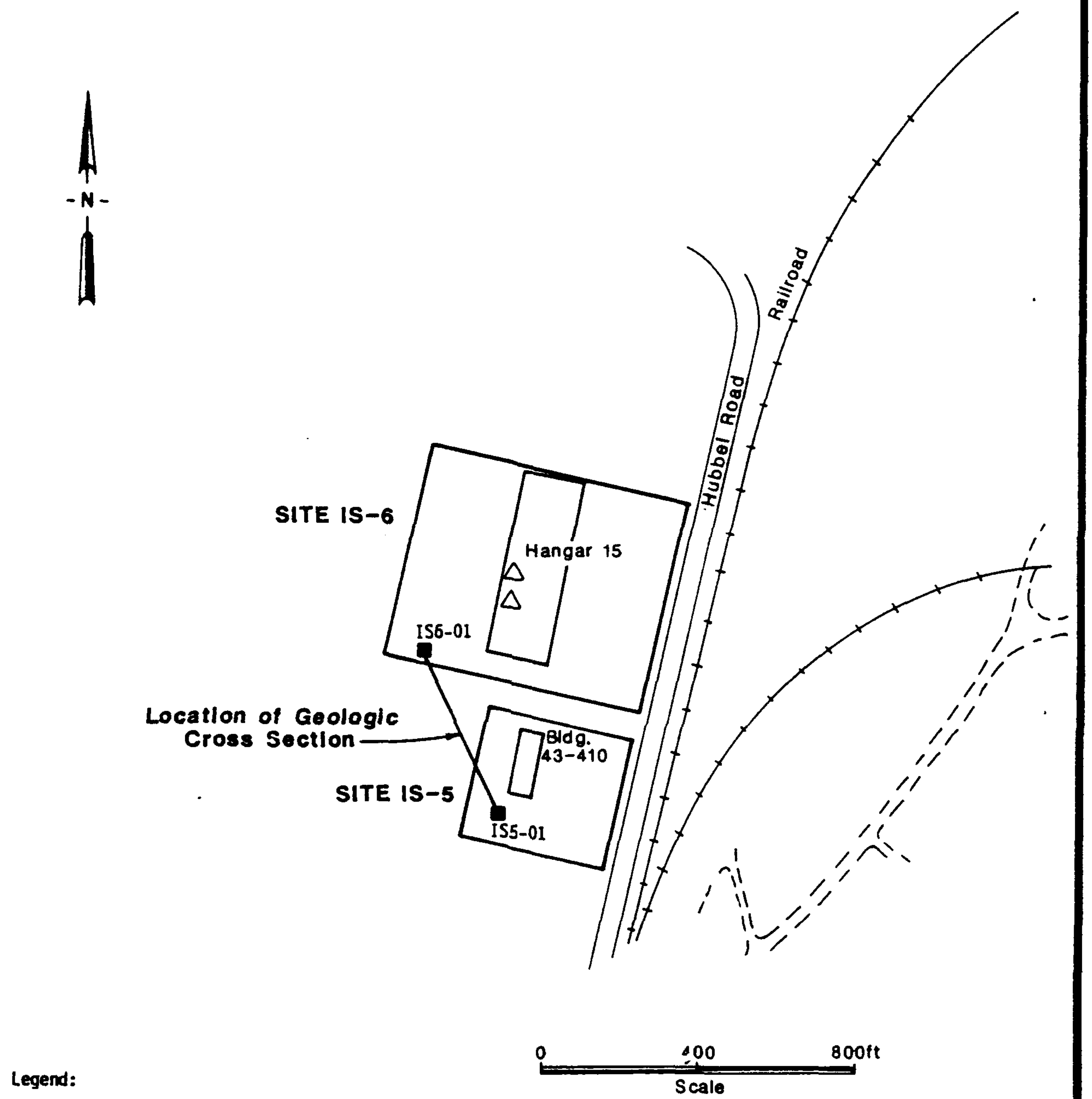


IS1-01 ■	Monitoring Well Location Stage 3
W-18 ⊙	Monitoring Well Location, Phase II, Stage 1
△	Dry Well Location

LOCATION MAP
SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.1



Legend:

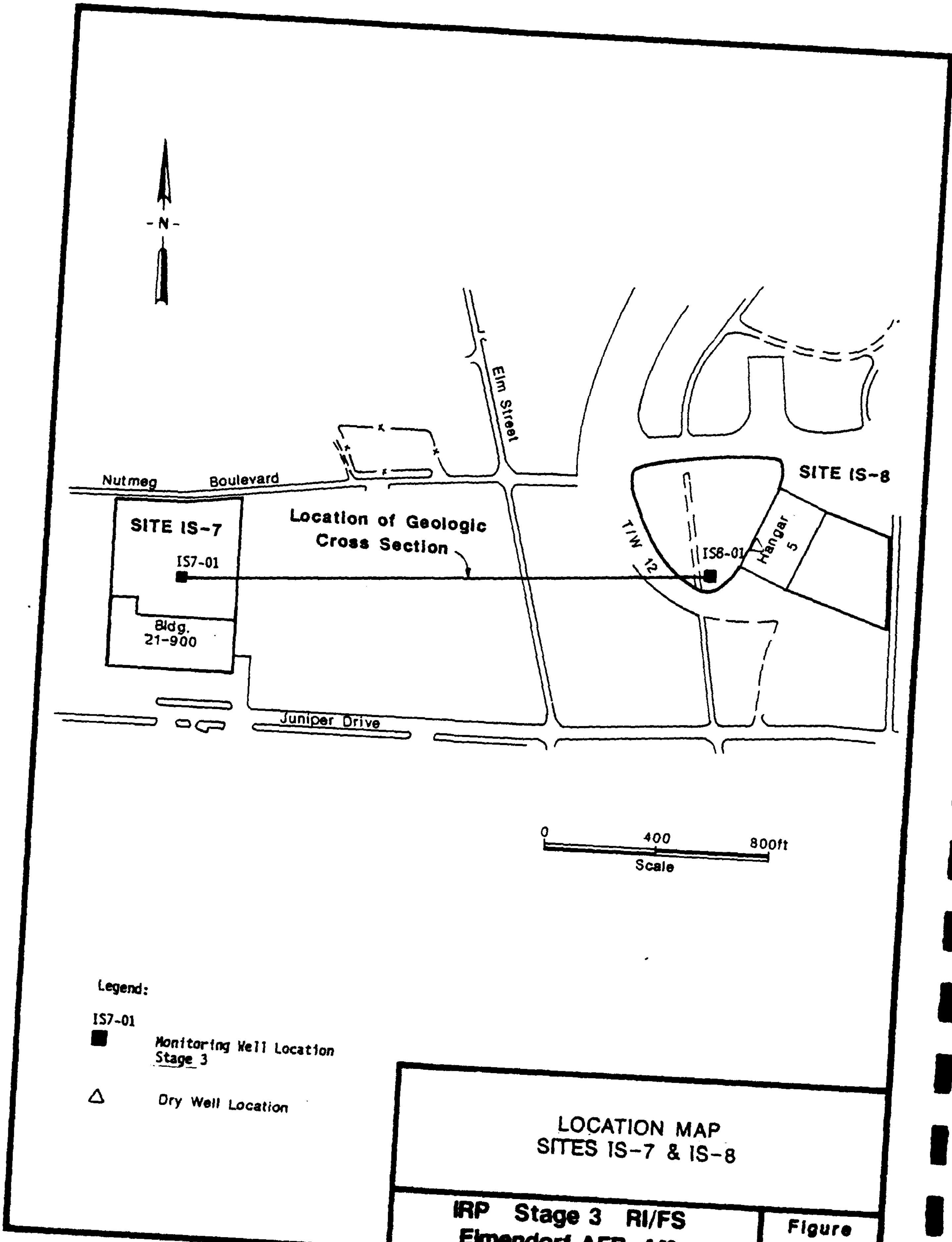
IS6-01 ■ Monitoring Well Location Stage 3

△ Dry Well Location

LOCATION MAP
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.2



LOCATION MAP
SITES IS-7 & IS-8

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.3

Site IS-6 (located at hangar 15): Hangar 15 is used for aircraft maintenance. Minor fuel spills in the hangar are likely to have been washed into the building floor drains.

Site IS-7 (located at building 21-900): This facility is used to maintain most of the vehicles on the base. A series of floor drains is connected to the 2 sumps and the seepage pit. It is likely that these drains have received spilled fuels and solvents.

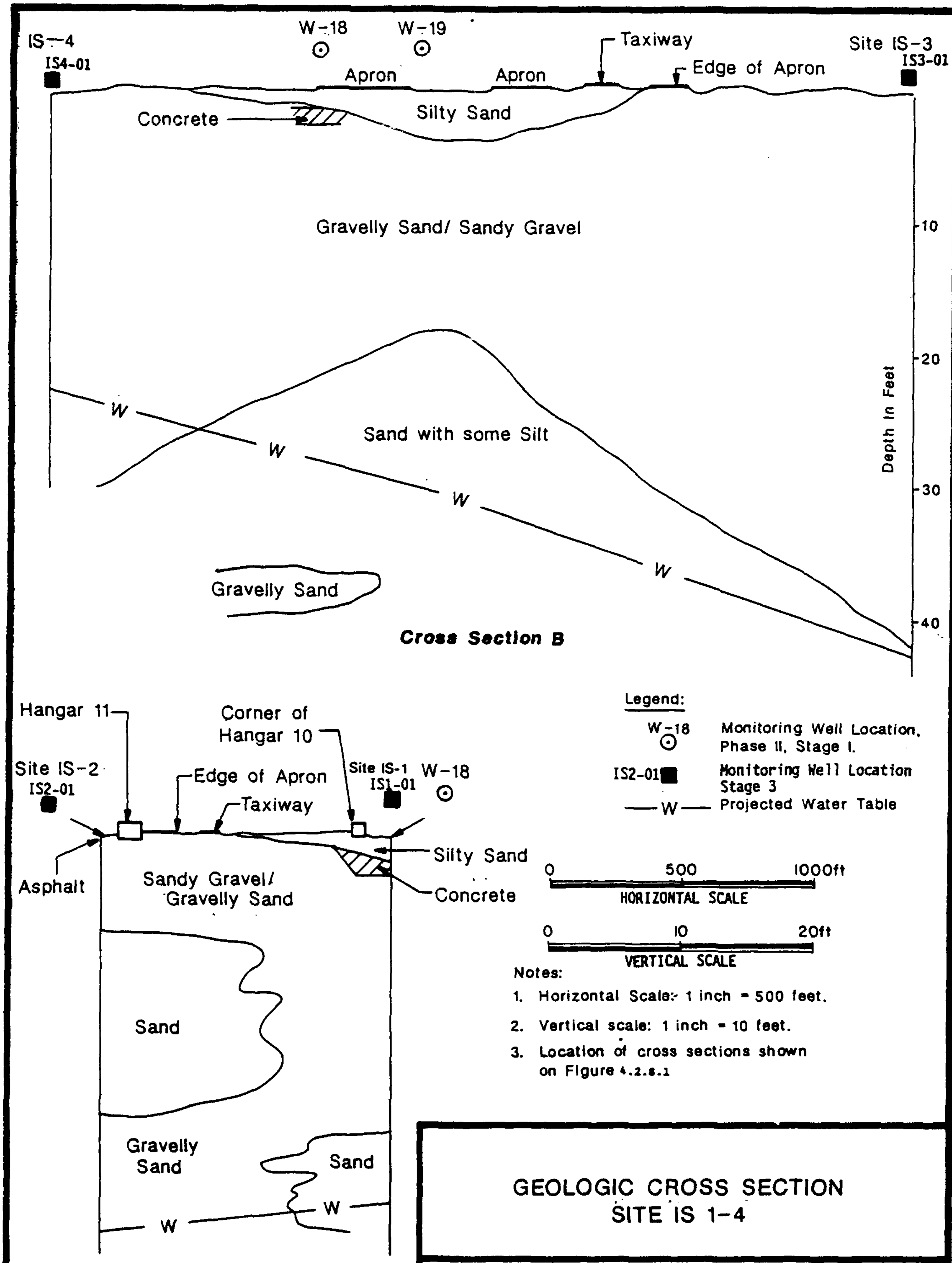
Site IS-8 (situated adjacent to hangar 5): This hangar is used as the aerial delivery facility and houses many pieces of ground equipment. Over a given 3-month period, about 55 gallons of the solvent PD-680 is used to clean and maintain this equipment; some of the spent solvent may enter the floor drains of the hangar (Engineering Science, 1983).

4.2.8.1 Presentation of Results at Sites IS-1 through IS-8

Results of the geologic and hydrogeologic investigations are presented below. Analytical results are tabulated and presented on the site maps.

4.2.8.1.1 Site Geology

Sites IS-1 through IS-8 are located on relatively flat terrain at elevations ranging from 150 to 215 feet. In general, the terrain slopes very gradually to the southwest. The sites are situated on late-Quaternary glacial outwash deposits consisting chiefly of sands and gravels with a minor amount of silt. The outwash deposits are bordered by a glacial moraine to the north and the Ship Creek floodplain to the south. At depth, the outwash overlies silt and clay units of the Bootlegger Cove Formation which act as an aquitard for the shallow water table. Geologic cross sections are presented in Figures 4.2.8.4 through 4.2.8.6 to depict subsurface materials beneath Sites IS-1 through IS-8.



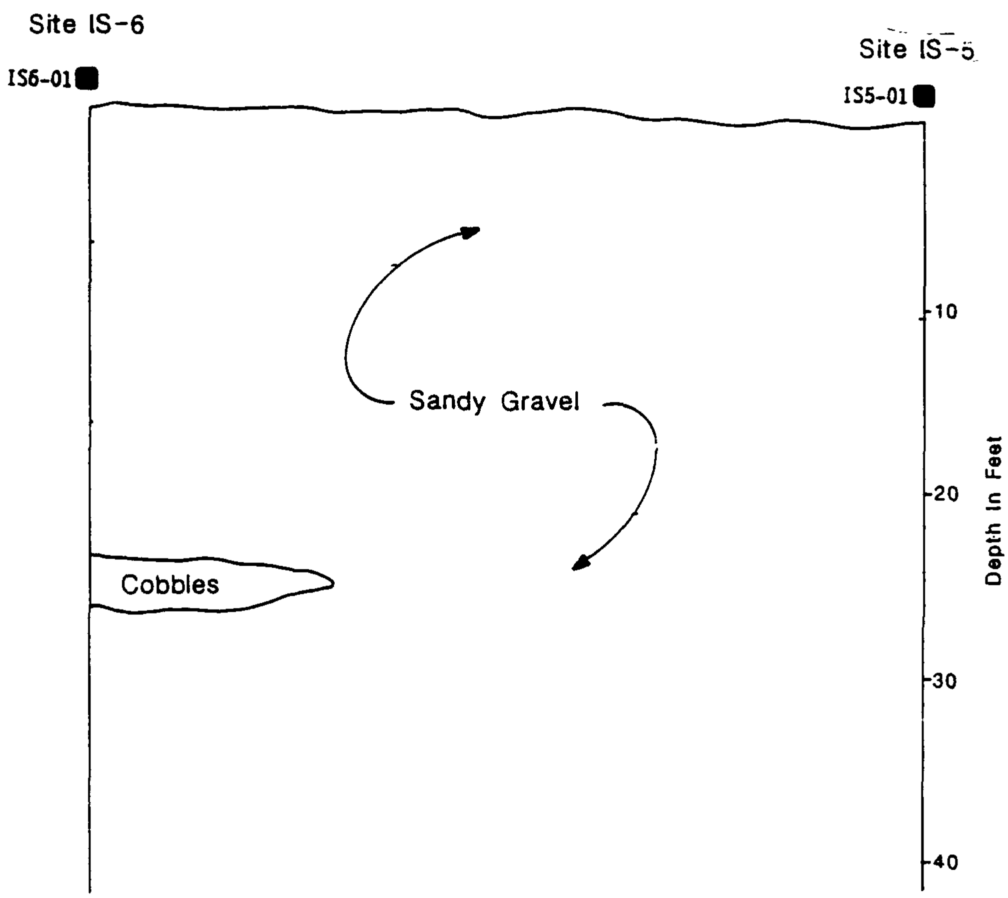
Notes:

1. Horizontal Scale: 1 inch = 500 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Location of cross sections shown on Figure 4.2.8.1

GEOLOGIC CROSS SECTION
SITE IS 1-4

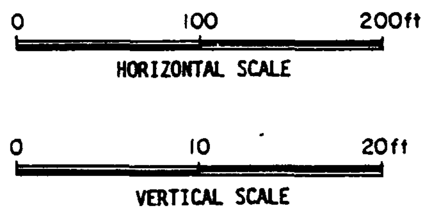
IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.4



Legend:

IS5-01 Monitoring Well Location Stage 3



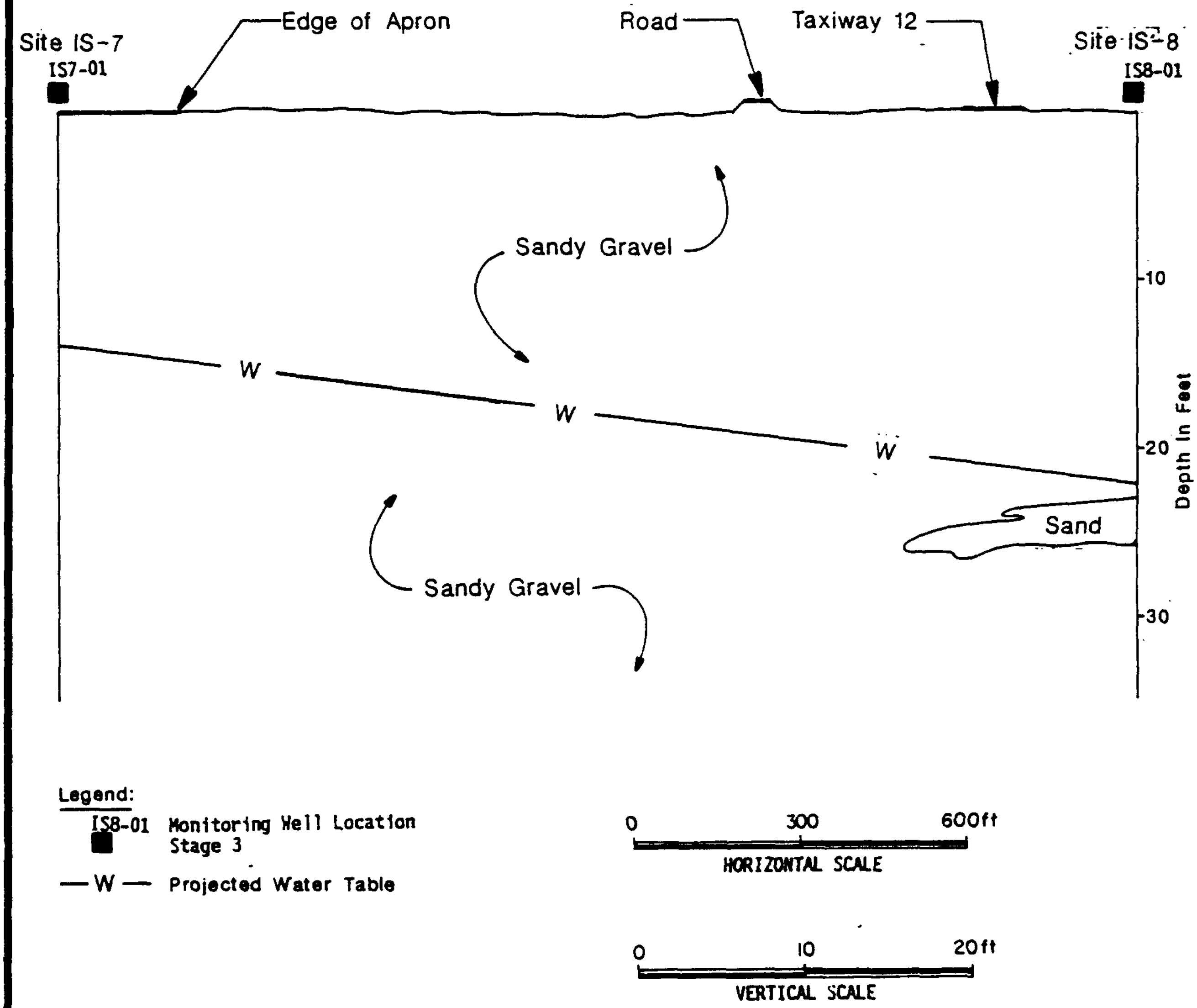
Note:

1. Horizontal scale: 1 inch = 100 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Location of cross section shown on Figure 4.2.8.2
4. Water table below 50 feet.

GEOLOGIC CROSS SECTION SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.5



Note:

1. Horizontal scale: 1 inch = 300 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Location of cross section shown on Figure 4.2.8.3

GEOLOGIC CROSS SECTION
SITES IS-7 & IS-8

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.6

The area of these sites has been cleared of most vegetation except grass, and the surface is extensively paved for roads, airport runways and taxiways. All the sites are located adjacent to buildings which have been used as shops or hangars for aircraft or vehicles.

4.2.8.1.1.1 Record Search

It was postulated in previous investigations that dry wells may have been used at these locations to dispose of floor wastes. A records search was conducted to locate utility as-builts. These as-builts did not show that dry wells were installed.

4.2.8.1.1.2 Geophysical Surveys

Geophysical surveys were conducted at Sites IS-1 through IS-8 to determine locations of dry wells. The dry wells were found under the buildings rather than outside the building. The inferred locations of the dry wells, based on analysis of as-built drawings, interviews with shop personnel, building and grounds inspections, and geophysical surveys are plotted on the site location maps (Figures 4.2.8.1 through 4.2.8.3). Electromagnetic geophysical survey methods were used to trace floor drains and associated underground piping. The methods included inductive and conductive signal tracing using a pipe and cable locator, and the use of ground penetrating radar. Terrain conductivity measurements were used outside several building sites to locate and delineate underground piping when appropriate. Ground penetrating radar was also used to identify buried obstructions near the proposed borings at each of the 8 sites.

4.2.8.1.1.3 Borings

One boring was drilled at each IS site, and each was completed as a monitoring well. Borings were located downgradient of the suspected dry wells as near as access would allow. All the borings encountered coarse sands and gravels with varying amounts of silt. A log of each

boring is presented in Appendix C. Downhole geophysical surveys (gamma logs) were conducted at Sites IS-3 and IS-8. Interpretation of the gamma logs are provided in Appendix D.

4.2.8.1.2 Site Hydrogeology

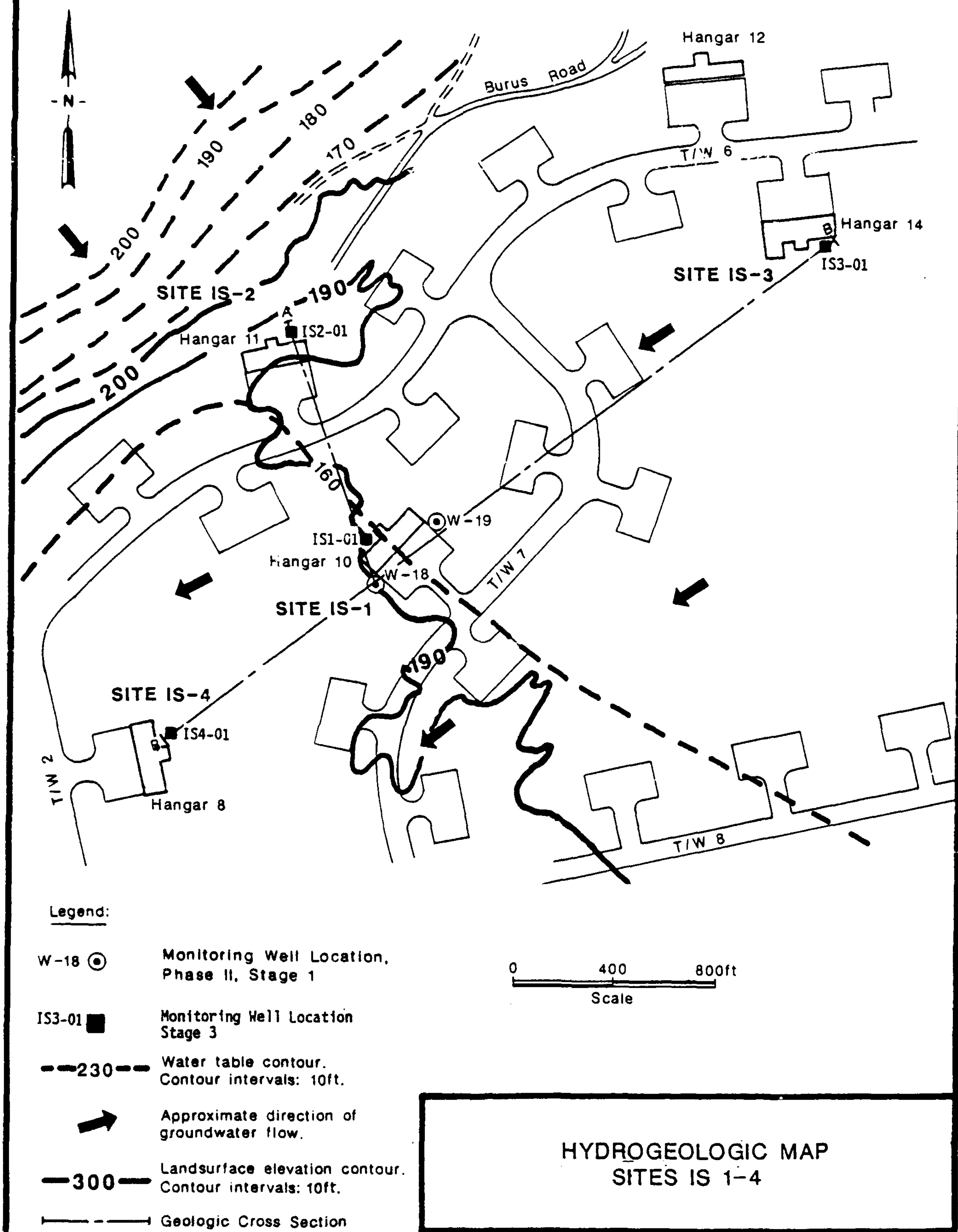
Sites IS-1, IS-2, IS-3 and IS-4 are underlain by sands and gravels with a water table depth of approximately 20 to 40 feet. The direction of groundwater flow was determined from comparison of regional trends with water level measurements at the wells located at each of the 4 sites. The groundwater flow is southwest with a gradient of approximatley 5 feet per mile (Figure 4.2.8.7). Hydraulic conductivity values have not yet been estimated for this site.

Sites IS-5 and IS-6 are underlain by gravels and sands with a water table depth of approximately 55 feet. The direction of groundwater flow is based on comparison of regional trends with water level measurements from the wells at the 2 sites. The groundwater flow is west-northwest with a gradient of approximately 10 feet per mile (Figure 4.2.8.8).

Sites IS-7 and IS-8 are underlain by sands and gravels with a water table depth of approximately 15 to 25 feet. The direction of groundwater flow was determined from a comparison of regional trends with water level measurements from the wells at the 2 sites. The groundwater flow is south with a gradient of approximately 45 feet per mile (Figure 4.2.8.9).

4.2.8.1.3 Analytical Results

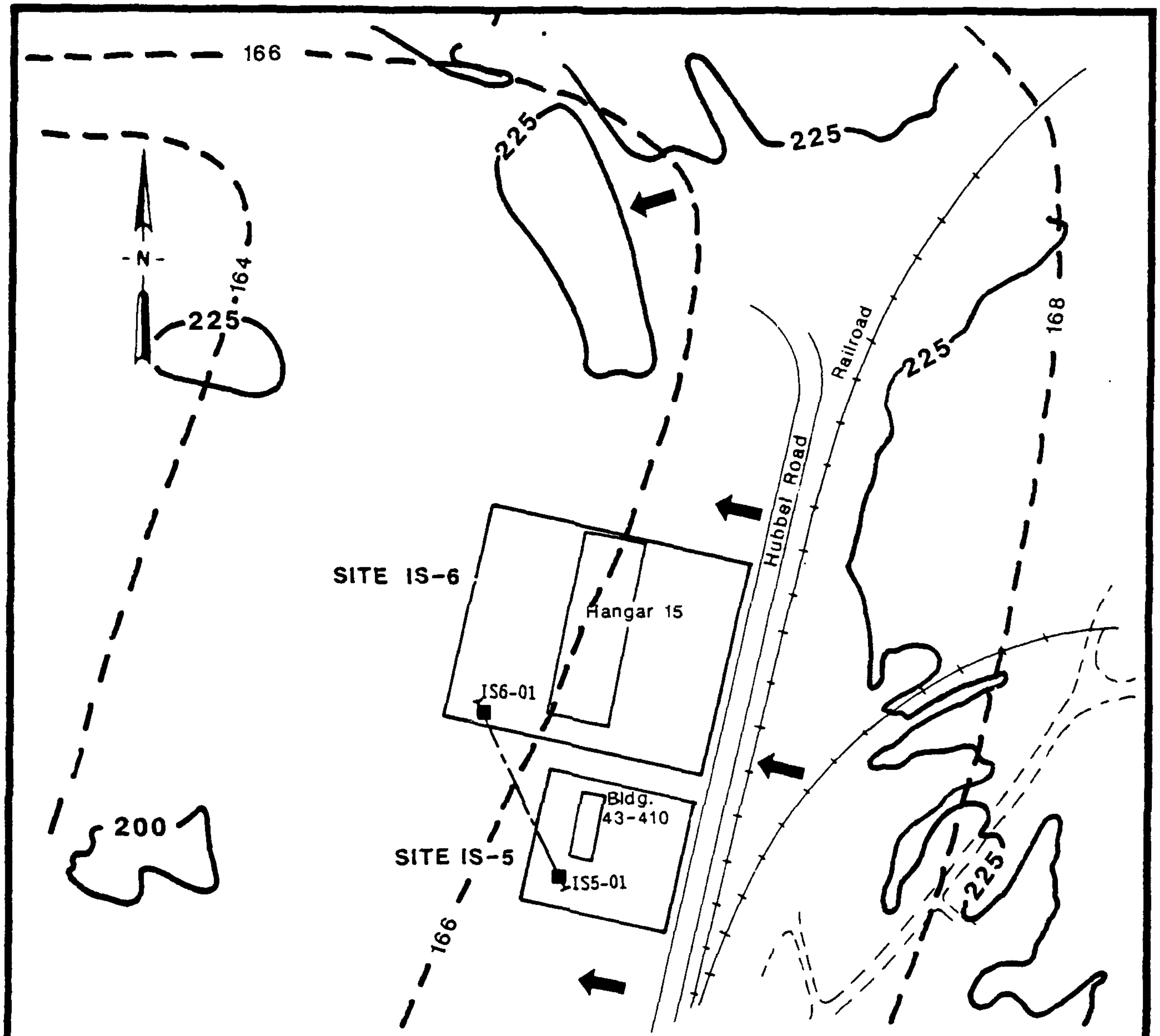
Field analytical results and observations and laboratory analytical results are discussed in the following sections.



HYDROGEOLOGIC MAP
SITES IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.7



Legend:

IS6-01 ■ Monitoring Well Location Stage 3

— —230— — Water table contour. Contour intervals: 2ft.

Approximate direction of groundwater flow.

—300— Landsurface elevation contour. Contour intervals: 25ft.

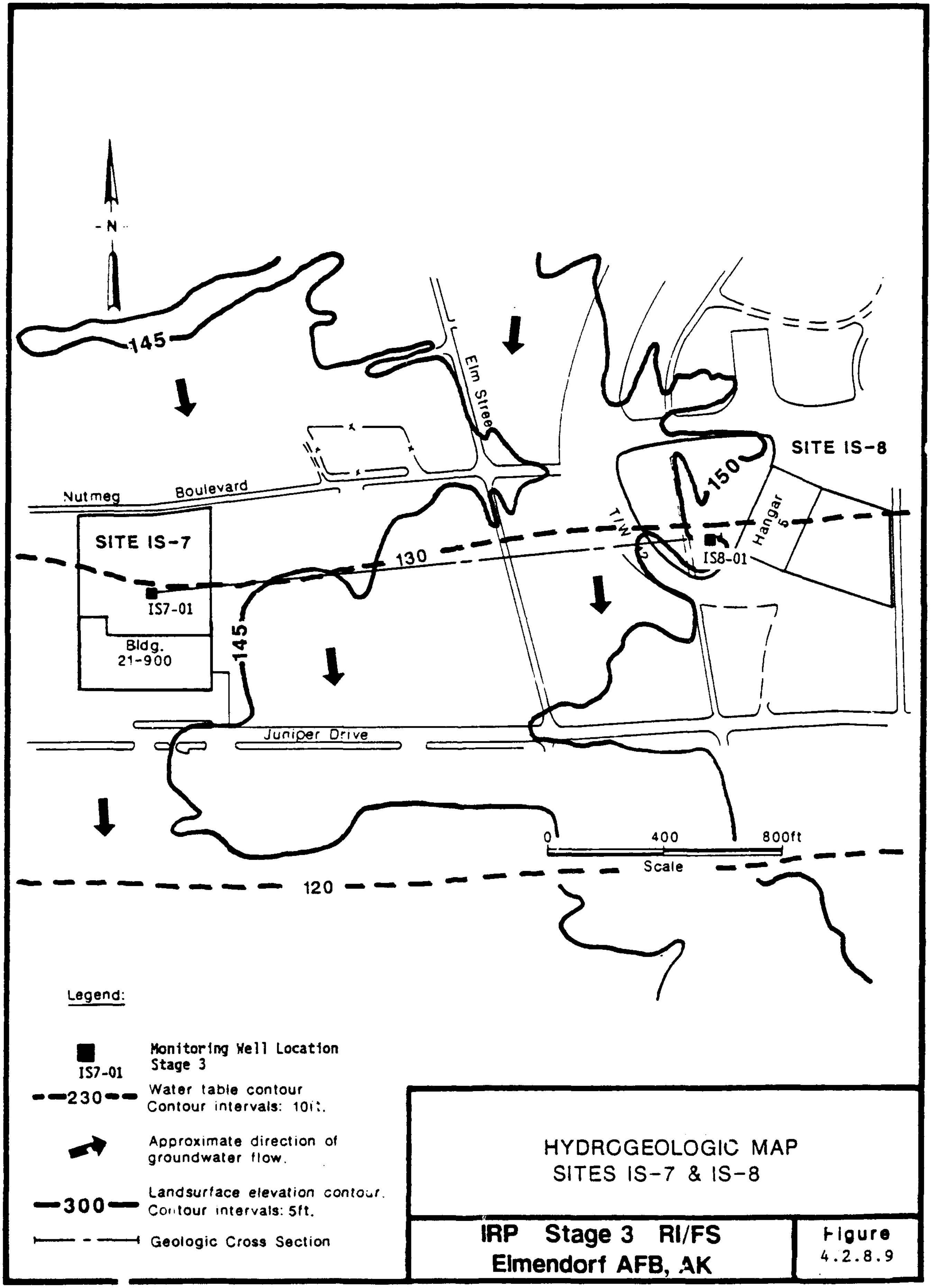
Geologic Cross Section

0 400 800ft
Scale

HYDROGEOLOGIC MAP
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.8



HYDROGEOLOGIC MAP
SITES IS-7 & IS-8

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.9

4.2.8.1.3.1 Field Analytical Results and Observations

Visual observations were made at all subsurface investigation sites. The following indications of contamination were observed:

- Site IS-1 - No petroleum odors or stains were apparent at Site IS-1. An HNu reading of 10 ppm was taken on the soil sample at the 25 foot depth. All other soil samples had HNu readings between 0.1 - 1.0 ppm.

- Site IS-2 - An active steady, slow drip of diesel fuel was observed from a fuel tank vent on the east side of Hangar 11 (building 42-425). The ground below the leak was stained, and there was an odor of diesel. At the boring, the following HNu readings were recorded:

  5 feet - 0.2 ppm
  10 feet - 0.5 ppm
  20 feet - 2 ppm

- Site IS-3 - At Site IS-3 an HNu reading of 0.2 ppm was recorded on a soil sample taken at 45 feet in water-saturated soil. There was no petroleum odor.

- Site IS-4 - The following HNu readings were recorded from soil samples taken from Site IS-4 at the indicated depths:

  10 feet - 2 ppm
  15 feet - 0.4 ppm
  20 feet - 0.5 ppm
  25 feet - 1.0 ppm
  31 feet - 0.5 ppm

- Site IS-5 - No evidence of contamination was observed at Site IS-5.

- Site IS-6 - The soil sample taken at a depth of 50 feet had an HNu reading of 0.1 ppm.

- Site IS-7 - No evidence of contamination was observed at Site IS-7.

- Site IS-8 - HNu readings of 0.5 ppm at 20 feet and 30 ppm at 25 feet were recorded on soil samples. There was a petroleum odor at 25 feet.

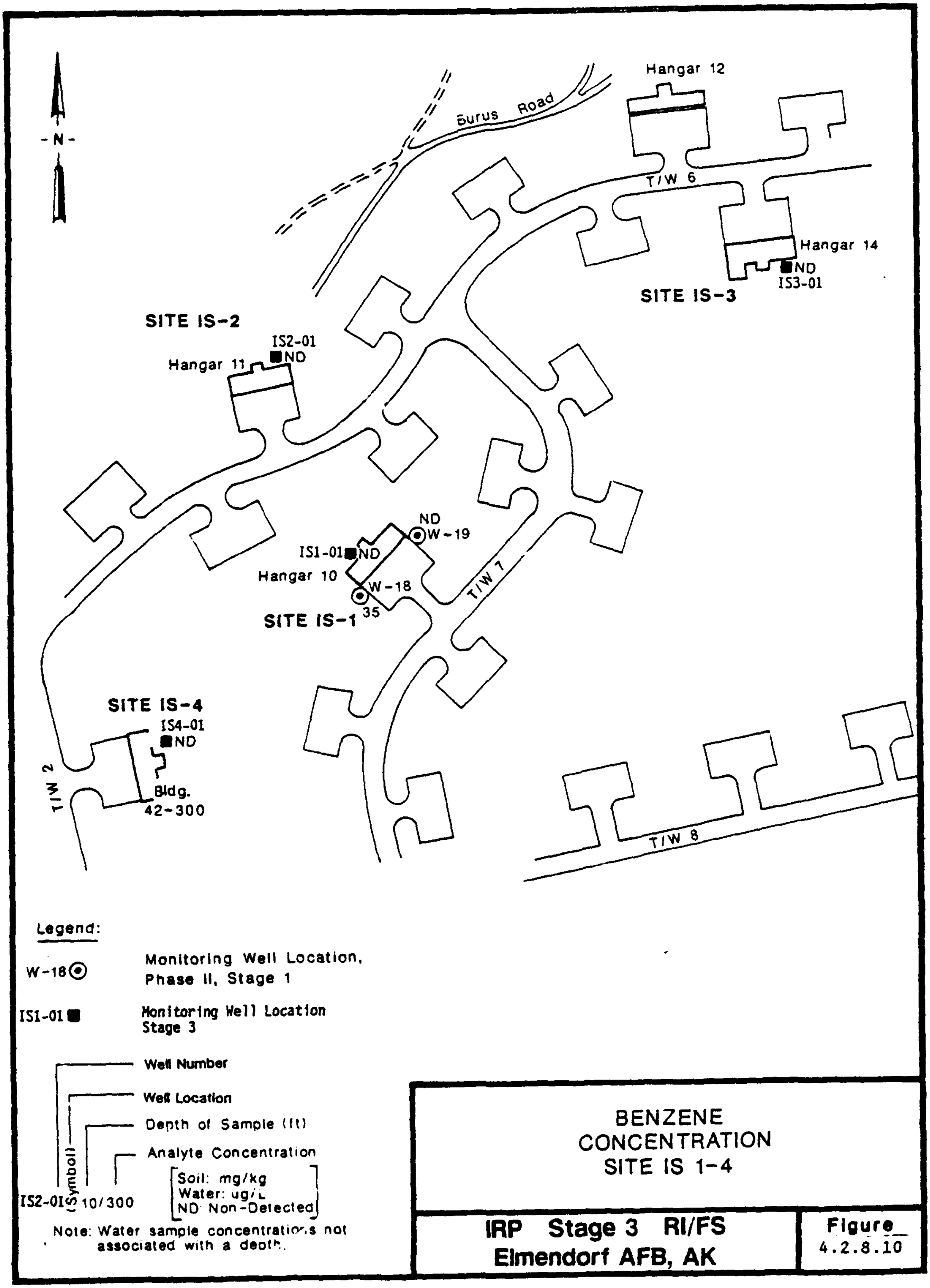
Field parameters measured at Sites IS-1 through IS-8 during groundwater sampling are presented in Table 4.2.8.1.

4.2.8.1.3.2 Laboratory Analytical Results

The laboratory analytical programs for Sites IS-1 through IS-8 is presented in Table 4.2.8.2, and the sample plan for the basewide field investigation program is included in Appendix B. Major petroleum-based contaminants identified from the laboratory analysis of samples collected at Sites IS-1 through IS-8 are plotted on Figures 4.2.8.10 through 4.2.8.46. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well or test boring. Sampling depths are included for the soil samples. Results of analytical tests are presented in Table 4.2.8.3.

4.2.8.1.4 Analytical Results Table

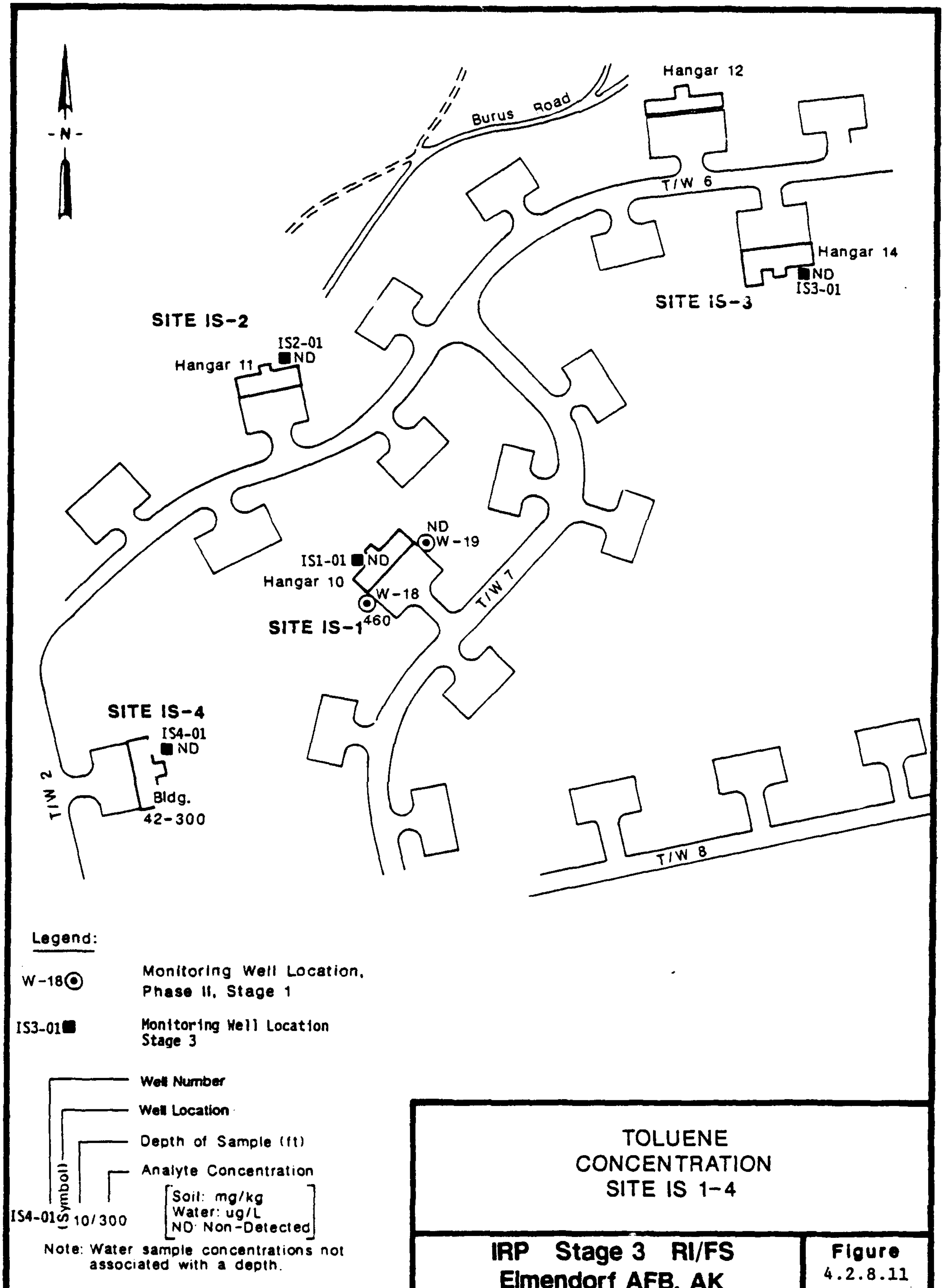
All of the laboratory analytical results for detected parameters at Sites IS-1 through IS-8 are presented on Table 4.2.8.3.



BENZENE CONCENTRATION SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

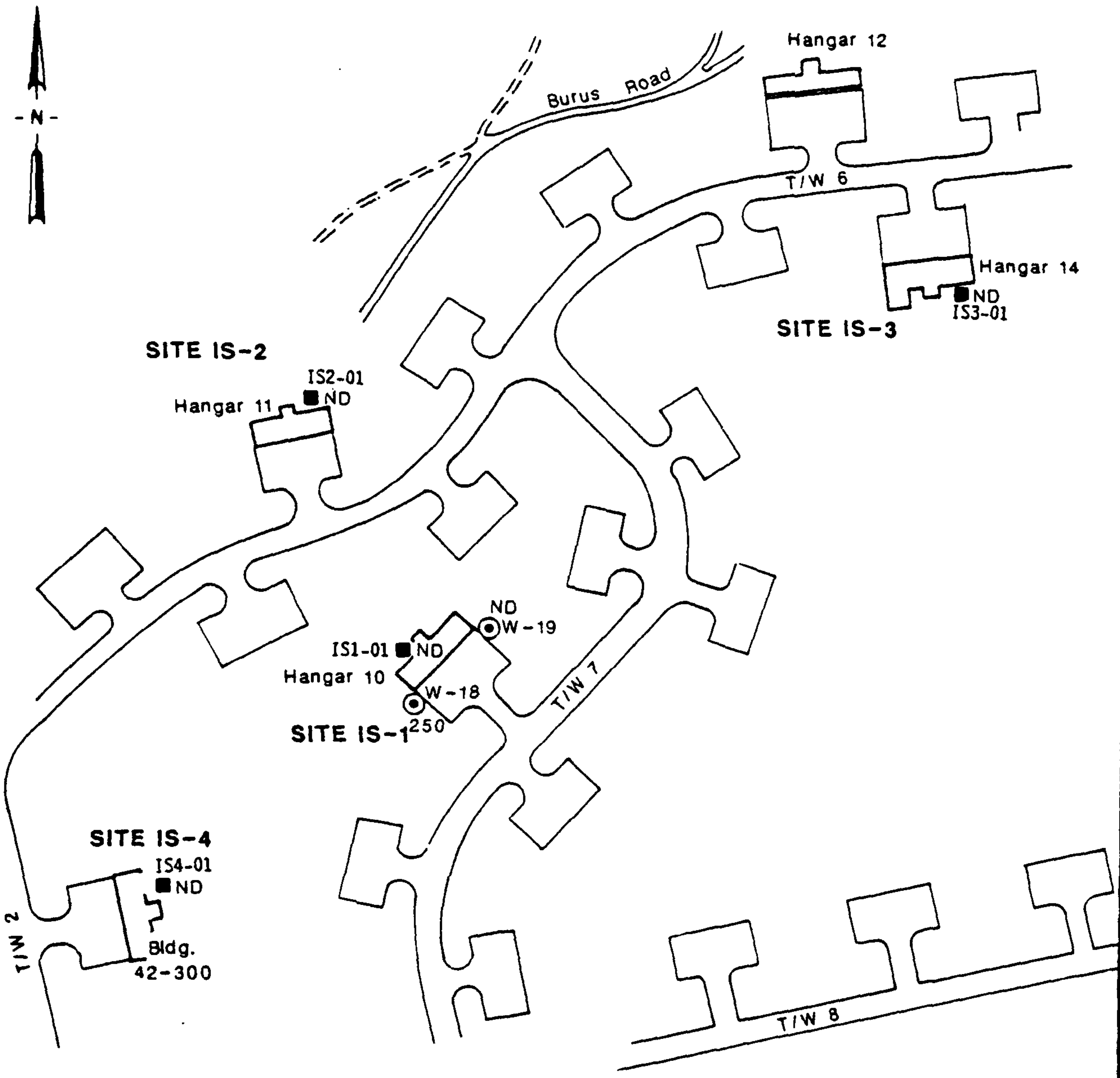
Figure 4.2.8.10



TOLUENE
CONCENTRATION
SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.11



Legend:

W-18 ◉ Monitoring Well Location, Phase II, Stage 1

IS1-01 ■ Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

IS2-01 (Symbol) 10/300

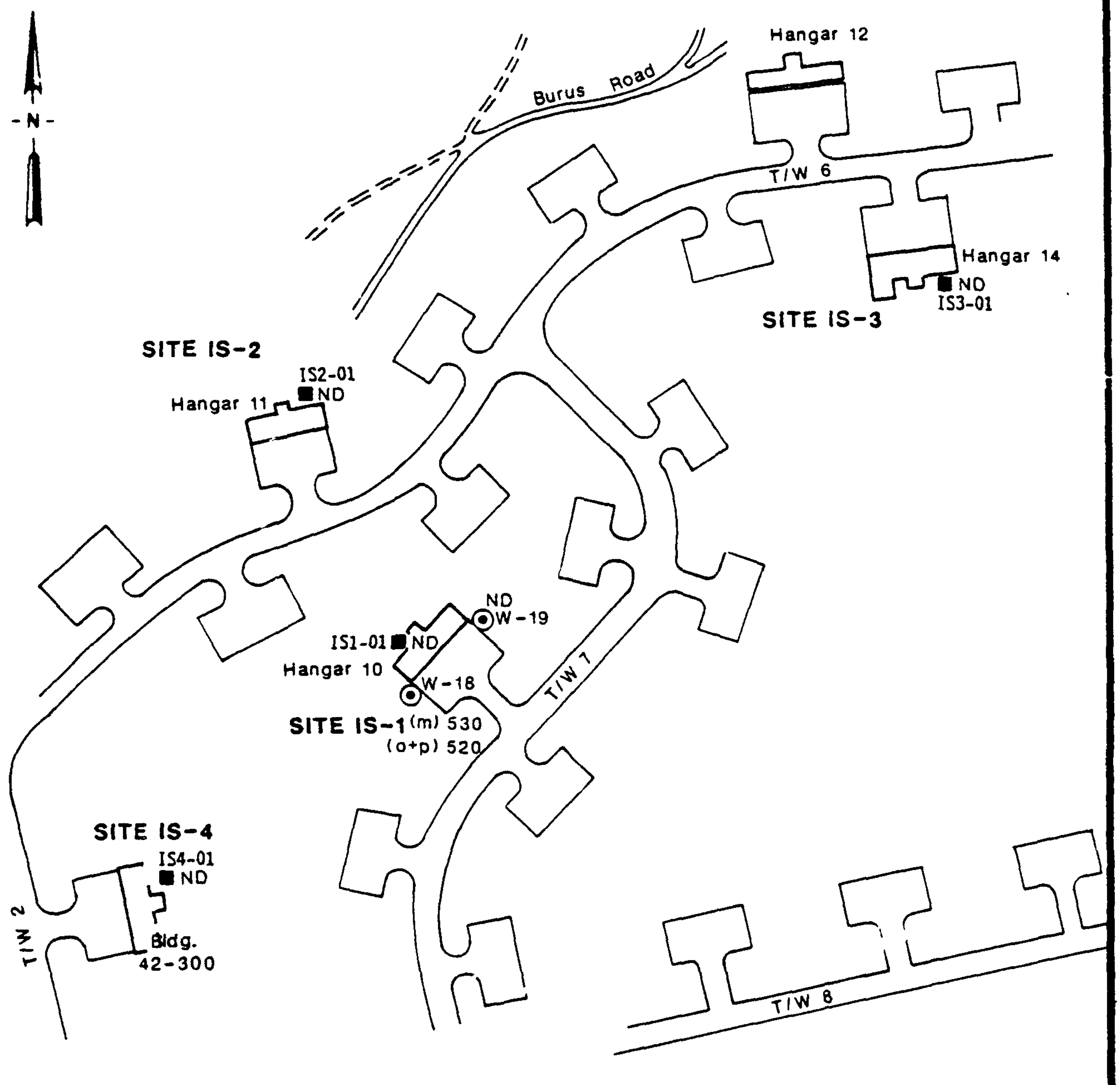
Soil: mg/kg
Water: ug/L
ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

ETHYL BENZENE
CONCENTRATION
SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.12



Legend:

W-18 ⊙ Monitoring Well Location, Phase II, Stage 1

IS3-01 ■ Monitoring Well Location Stage 3

Well Number
Well Location
Depth of Sample (ft)
Analyte Concentration

IS4-01 (Symbol) 10/300

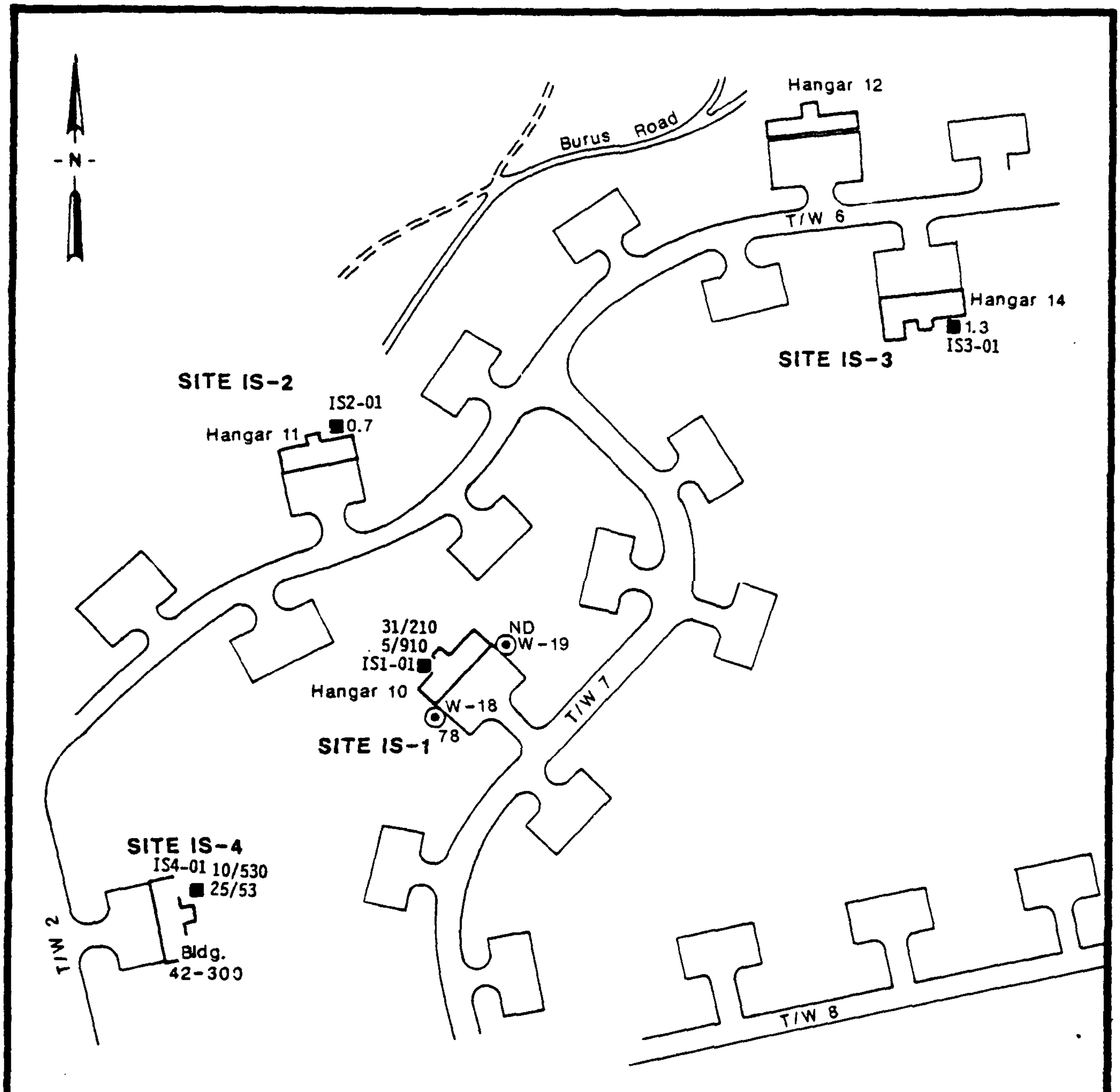
Soil: mg/kg
Water: ug/L
ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

(m), (o+p) AND TOTAL XYLENE CONCENTRATION SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.13



Legend:

W-18 ⊙ Monitoring Well Location, Phase II, Stage 1

IS1-01 ■ Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

IS2-01 (Symbol) 10/300

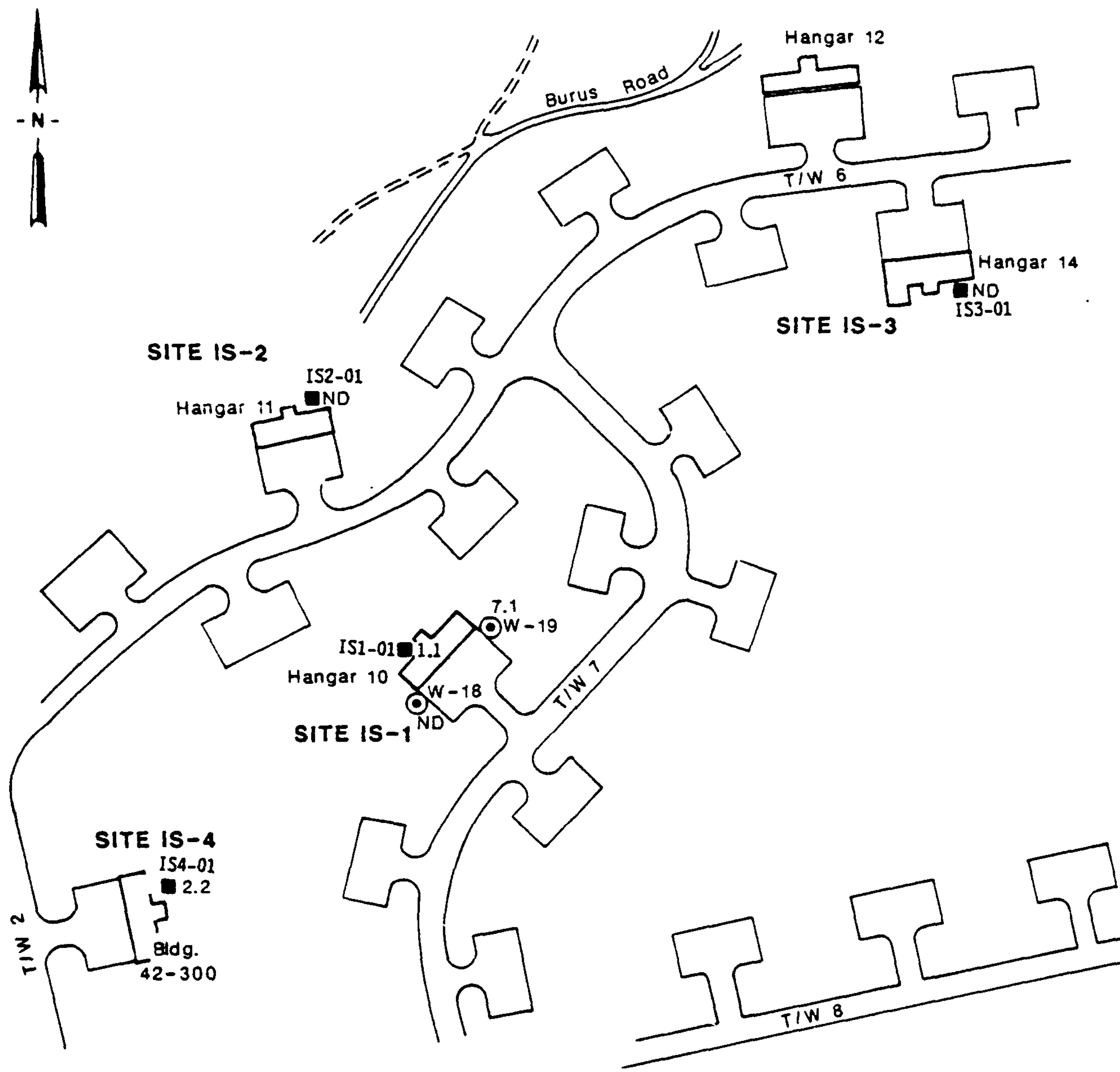
[Soil: mg/kg
Water: mg/L
ND Non-Detected]

Note: Water sample concentrations not associated with a depth.

TOTAL PETROLEUM HYDROCARBON CONCENTRATION
SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.14



Legend:

W-18 ⊙ Monitoring Well Location, Phase II, Stage 1

IS4-01 ■ Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

IS4-01 (Symbol) 10/300

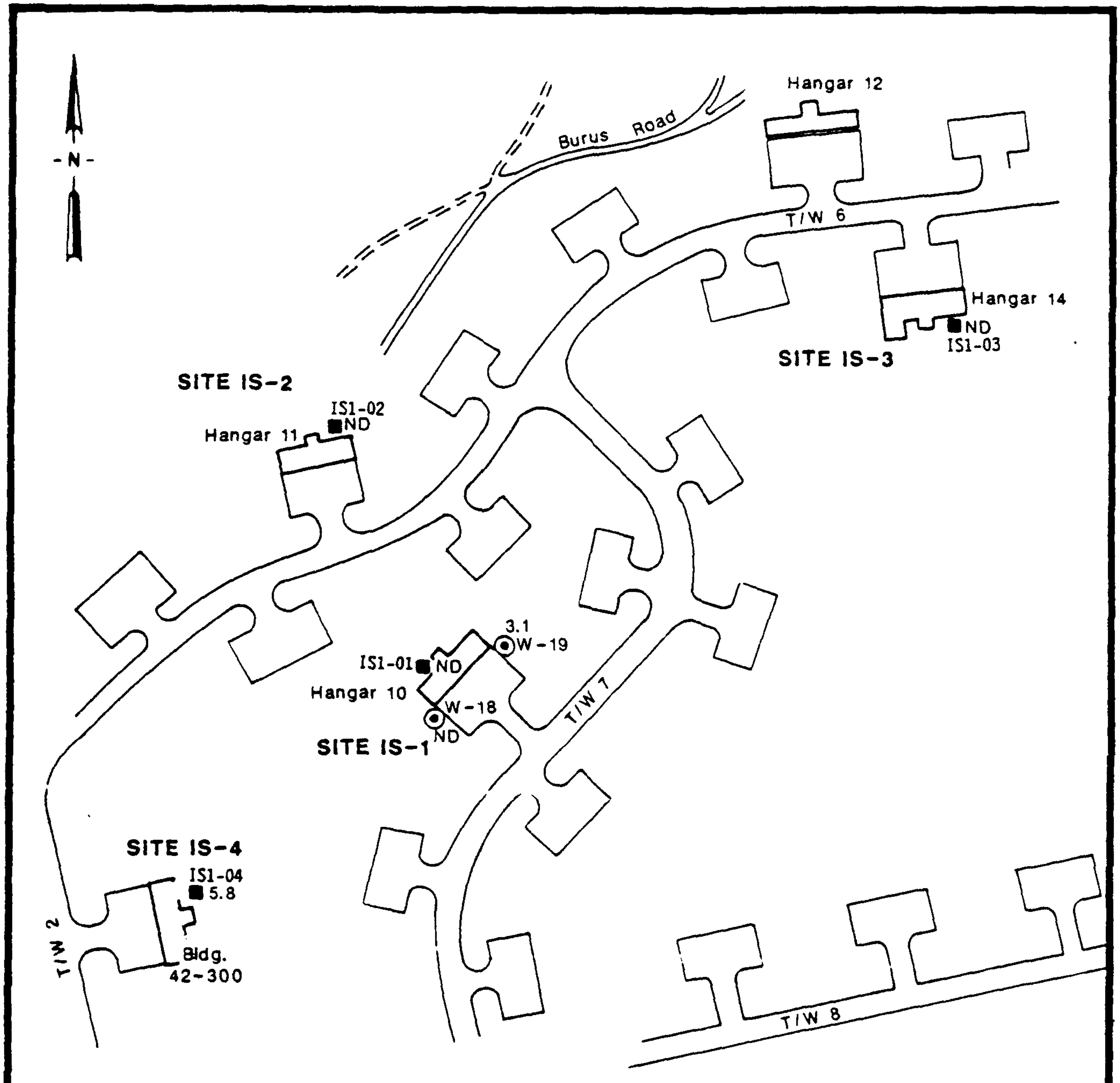
Soil: mg/kg
Water: ug/L
ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

1,1-DICHLOROETHANE CONCENTRATION SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.15



Legend:

W-18 — Monitoring Well Location, Phase II, Stage 1

IS1-01 — Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

IS2-01 (Symbol) 10/300

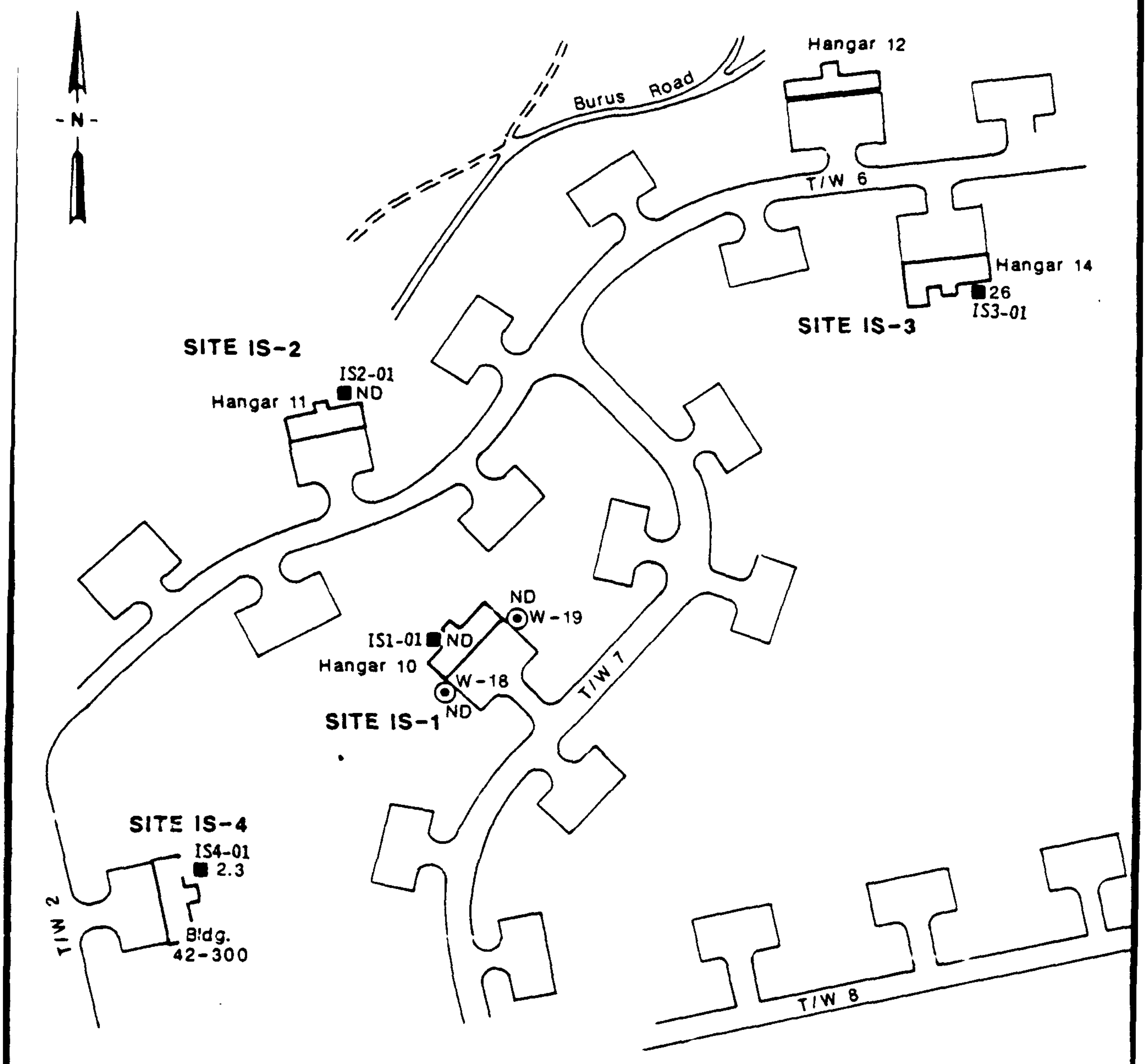
[Soil: mg/kg
Water: ug/L
ND Non-Detected]

Note: Water sample concentrations not associated with a depth.

1,1,1-TRICHLOROETHANE
CONCENTRATION
SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.16



Legend:

W-18 ⦿ Monitoring Well Location, Phase II, Stage 1

IS1-01 ■ Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

IS3-01 (Symbol) 10/300

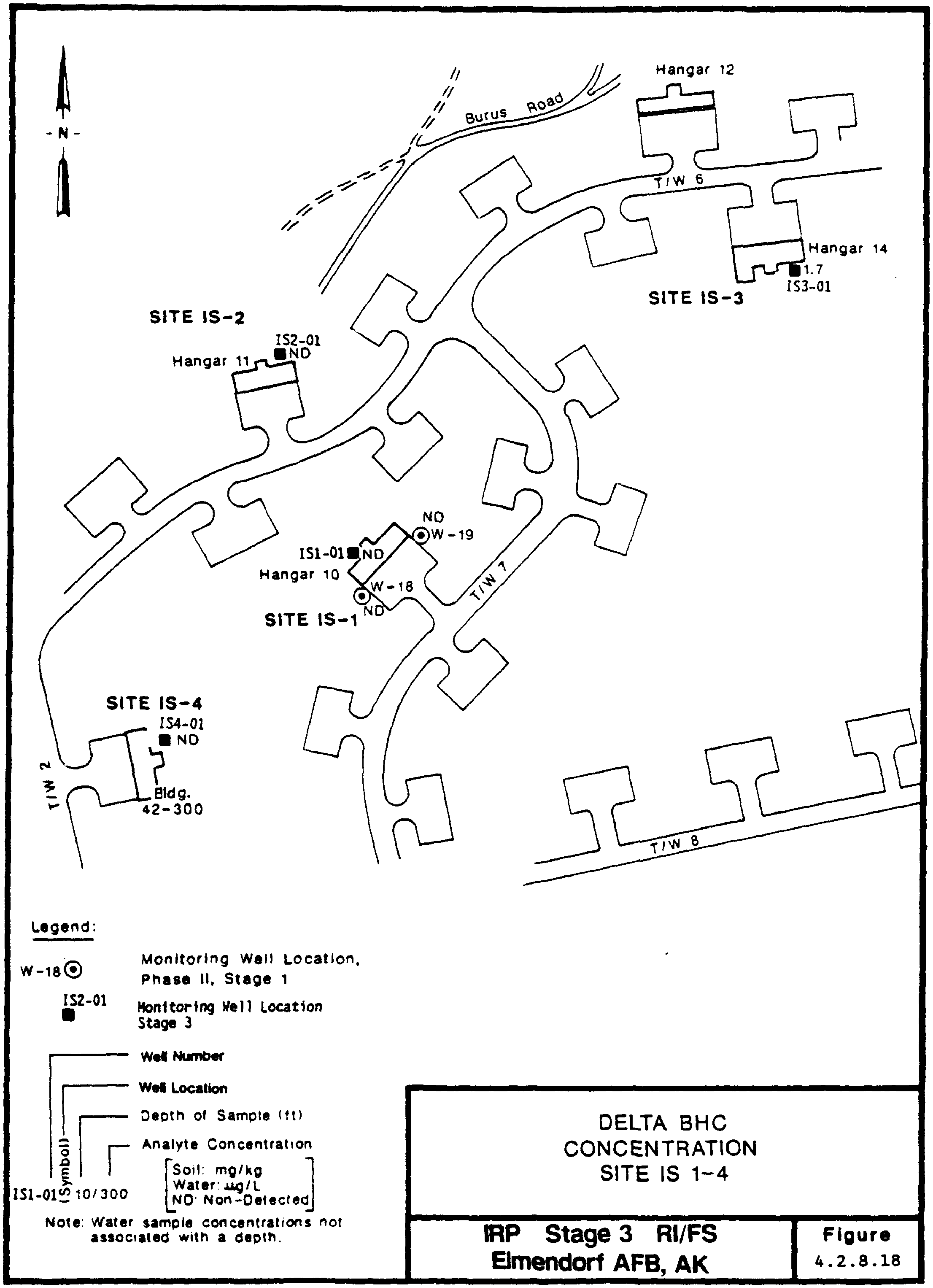
[Soil: mg/kg
Water: µg/L
ND: Non-Detected]

Note: Water sample concentrations not associated with a depth.

ALPHA BHC
CONCENTRATION
SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

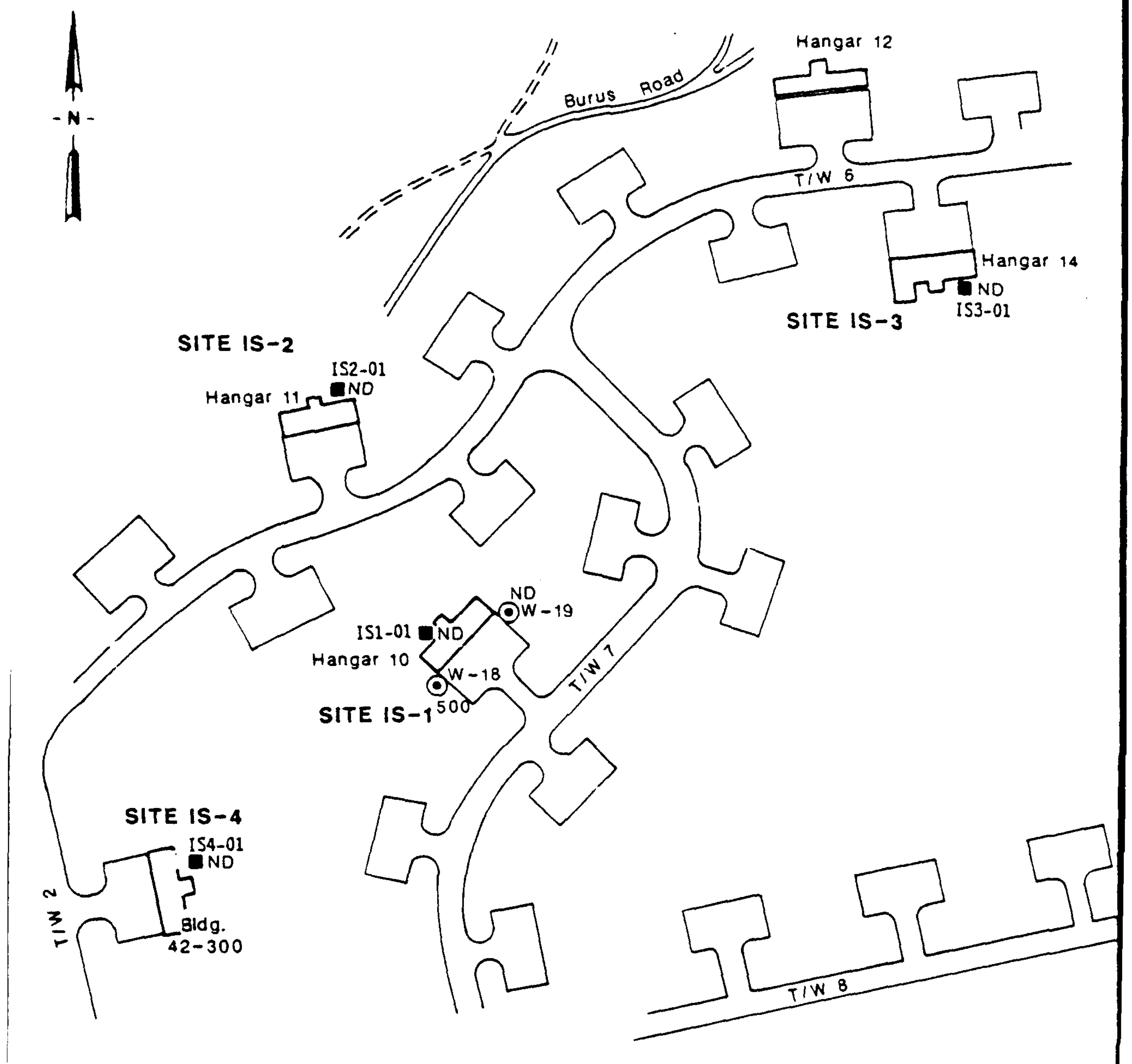
Figure
4.2.8.17



DELTA BHC CONCENTRATION SITE IS 1-4

IRP Stage 3 RI/FS Elmendorf AFB, AK

Figure 4.2.8.18



Legend:

W-18 ◉ Monitoring Well Location, Phase II, Stage 1

IS3-01 ■ Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

(Symbol)

IS4-01 ■ 10/300

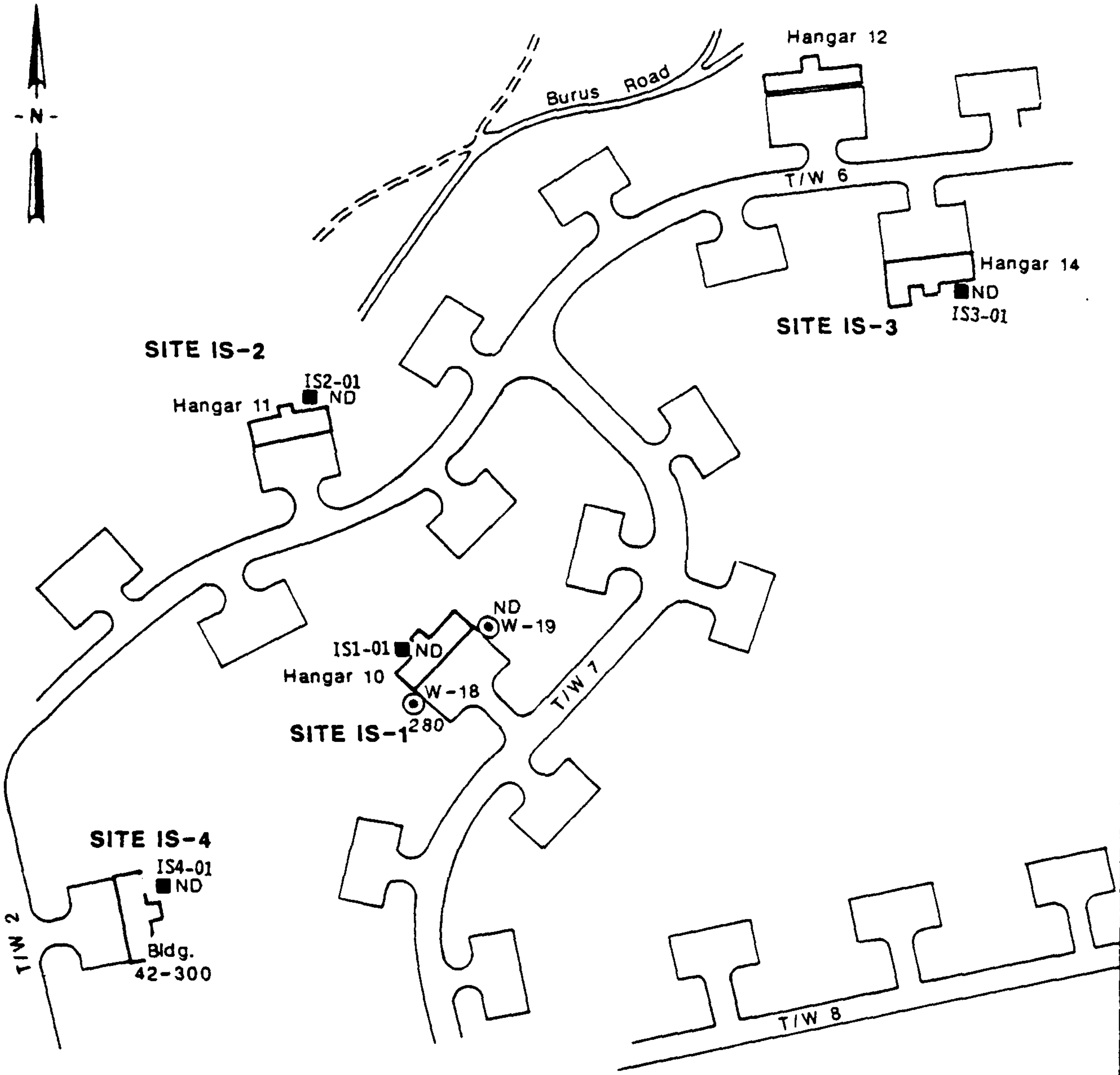
Soil: mg/kg
Water: µg/L
ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

2-METHYLNAPHTHALENE CONCENTRATION SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.19



Legend:

W-18 ⊙ Monitoring Well Location, Phase II, Stage 1

IS1-01 ■ Monitoring Well Location Stage 3

IS2-01 (Symbol) 10/300

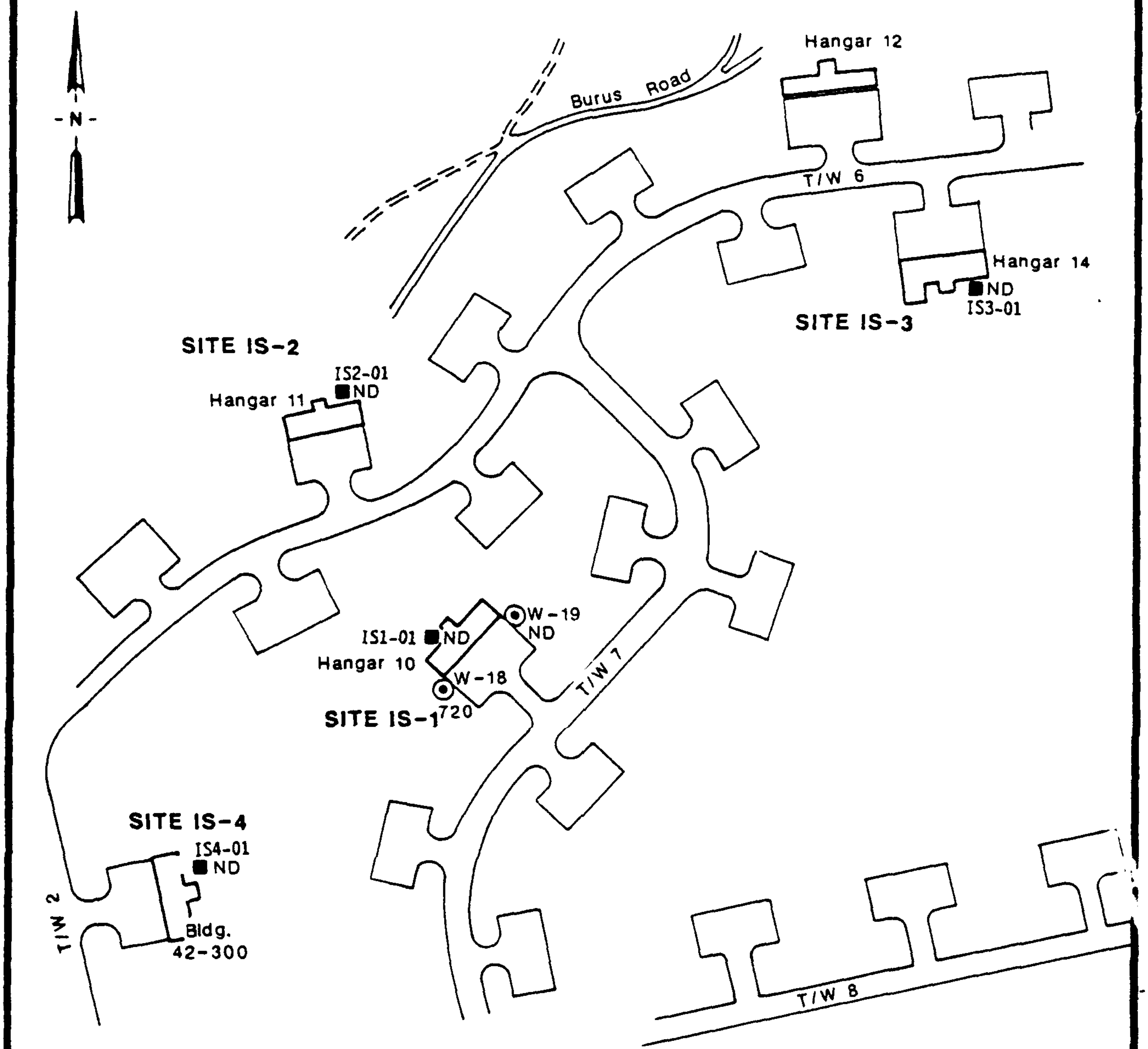
- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: µg/L
  - ND Non-Detected

Note: Water sample concentrations not associated with a depth.

NAPHTHALENE CONCENTRATION SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.20



Legend:

W-18 ⊙ Monitoring Well Location, Phase II, Stage 1

IS2-01 ■ Monitoring Well Location Stage 3

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration

IS3-01 (Symbol) 10/300

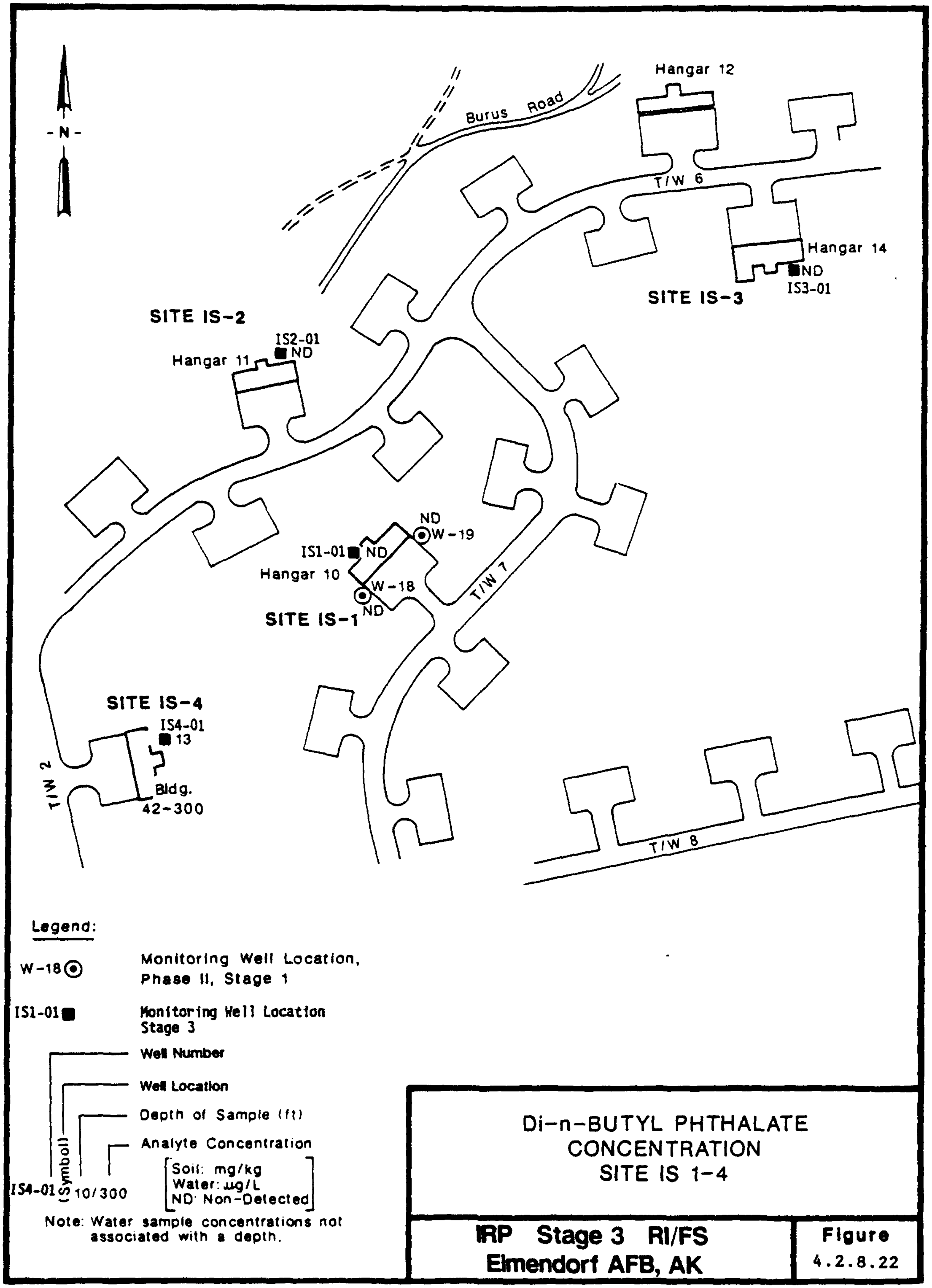
Soil: mg/kg
Water: µg/L
ND Non-Detected

Note: Water sample concentrations not associated with a depth.

bis(2-ETHYLHEXYL) PHTHALATE CONCENTRATION SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

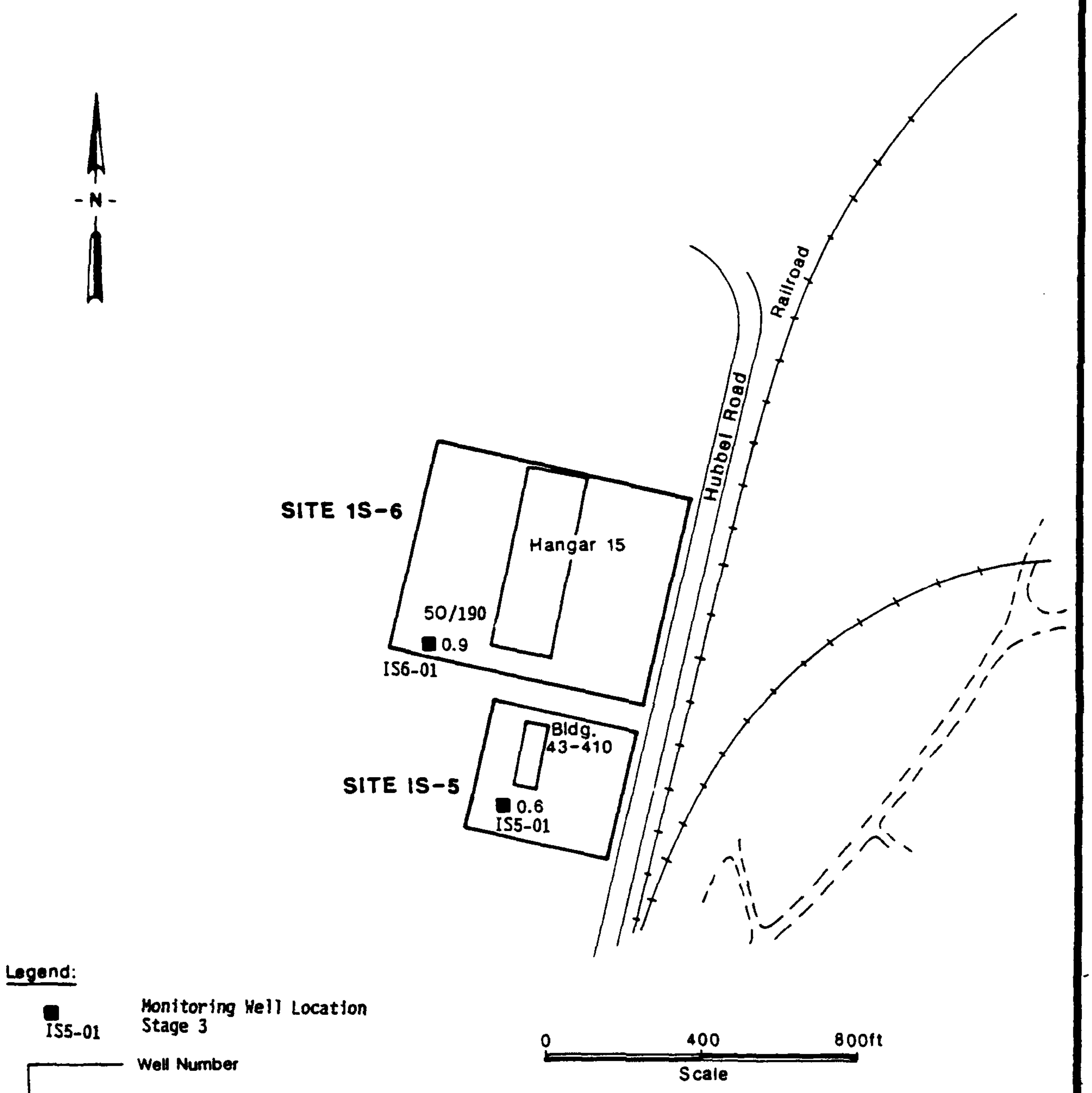
Figure 4.2.87.21



Di-n-BUTYL PHTHALATE CONCENTRATION SITE IS 1-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.22



Legend:

IS5-01 — Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

(Symbol) 10/300

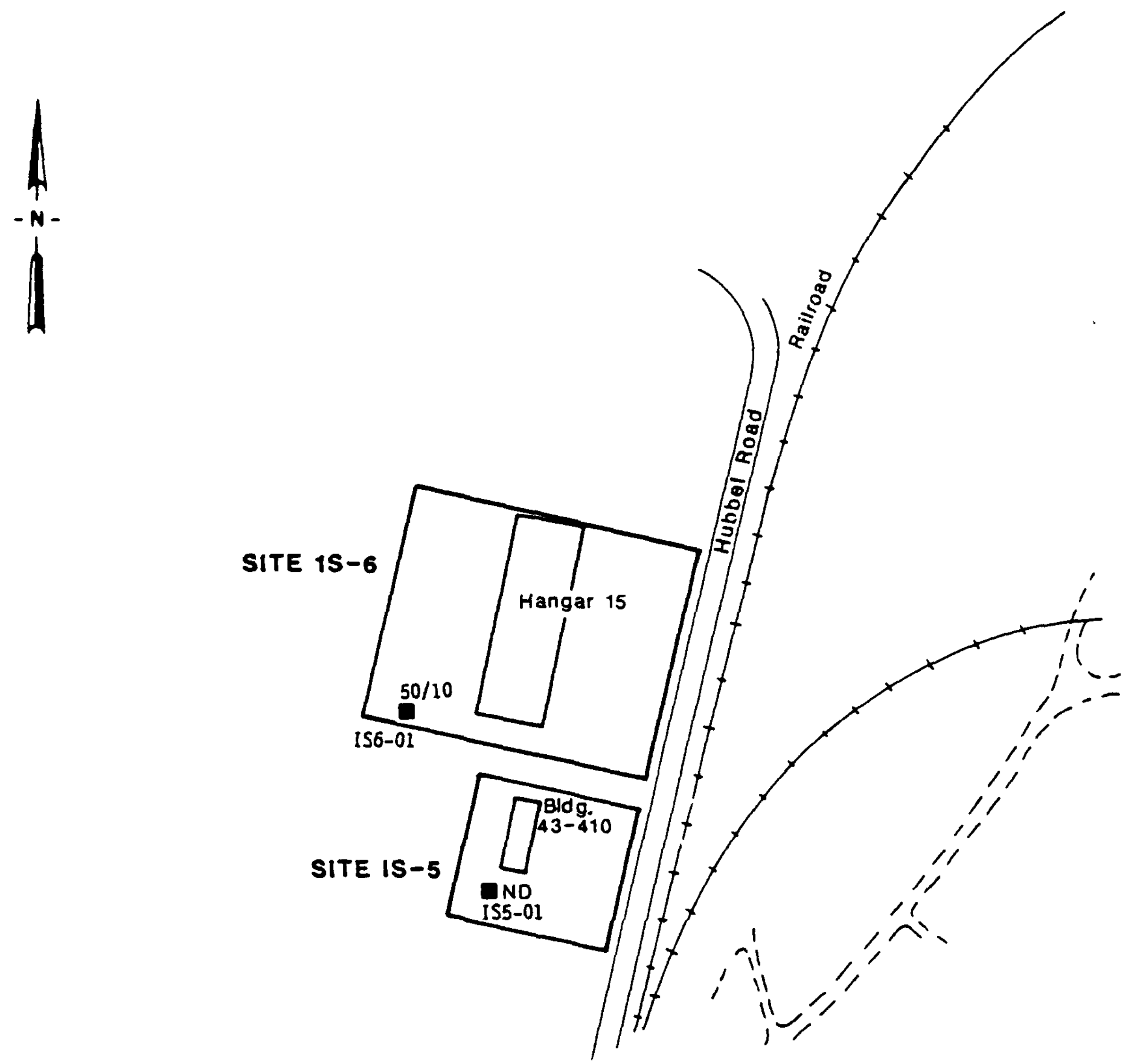
Soil: mg/kg
Water: mg/L
ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

TOTAL PETROLEUM HYDROCARBON CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.23



0 400 800ft
Scale

Legend:

IS5-01 — Monitoring Well Location Stage 3

IS6-01 (Symbol) 10/300

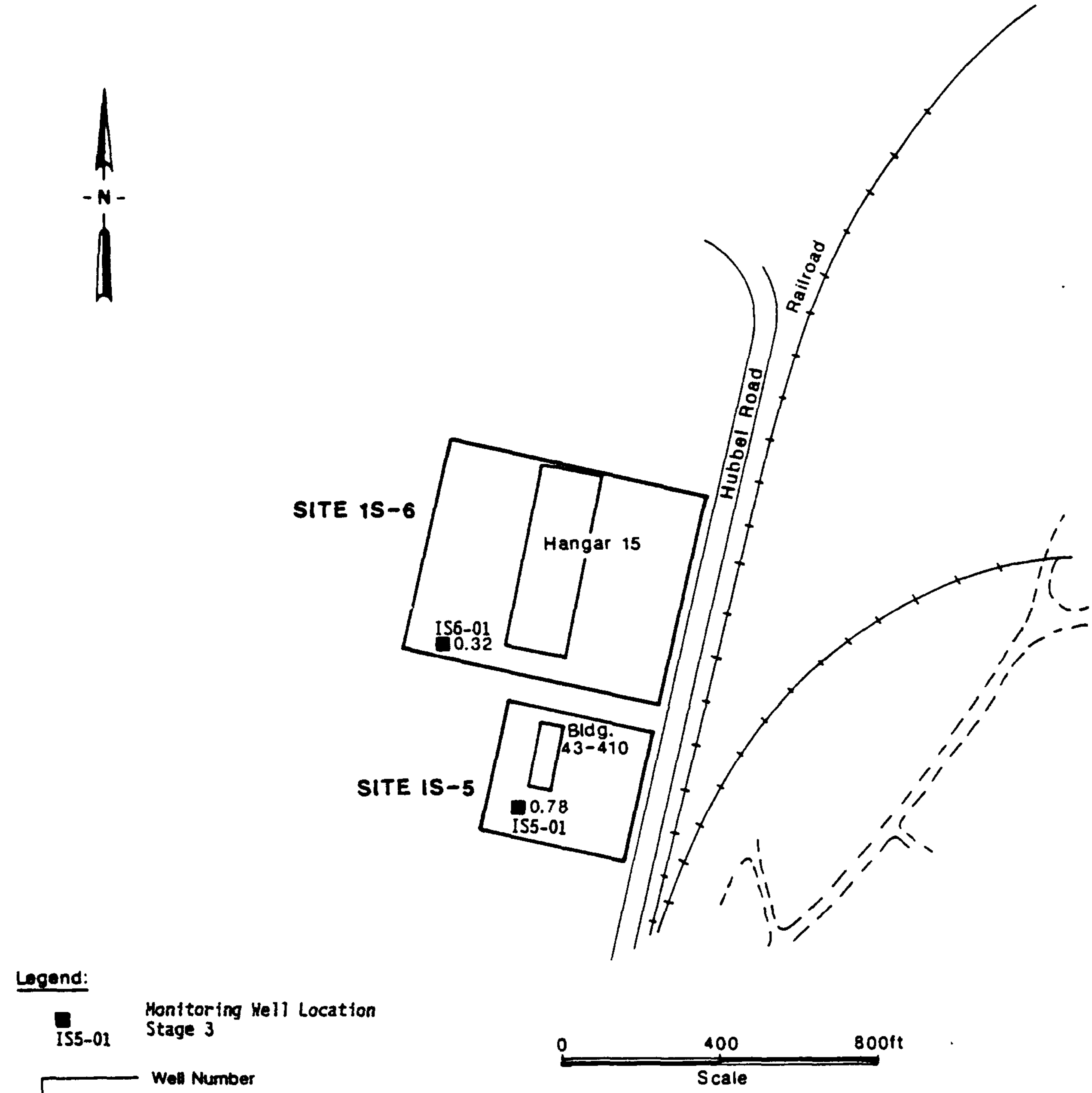
- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: ug/L
  - ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

2-BUTANONE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.24



Legend:

■ IS5-01 — Monitoring Well Location Stage 3

IS6-01 (Symbol) 10/300

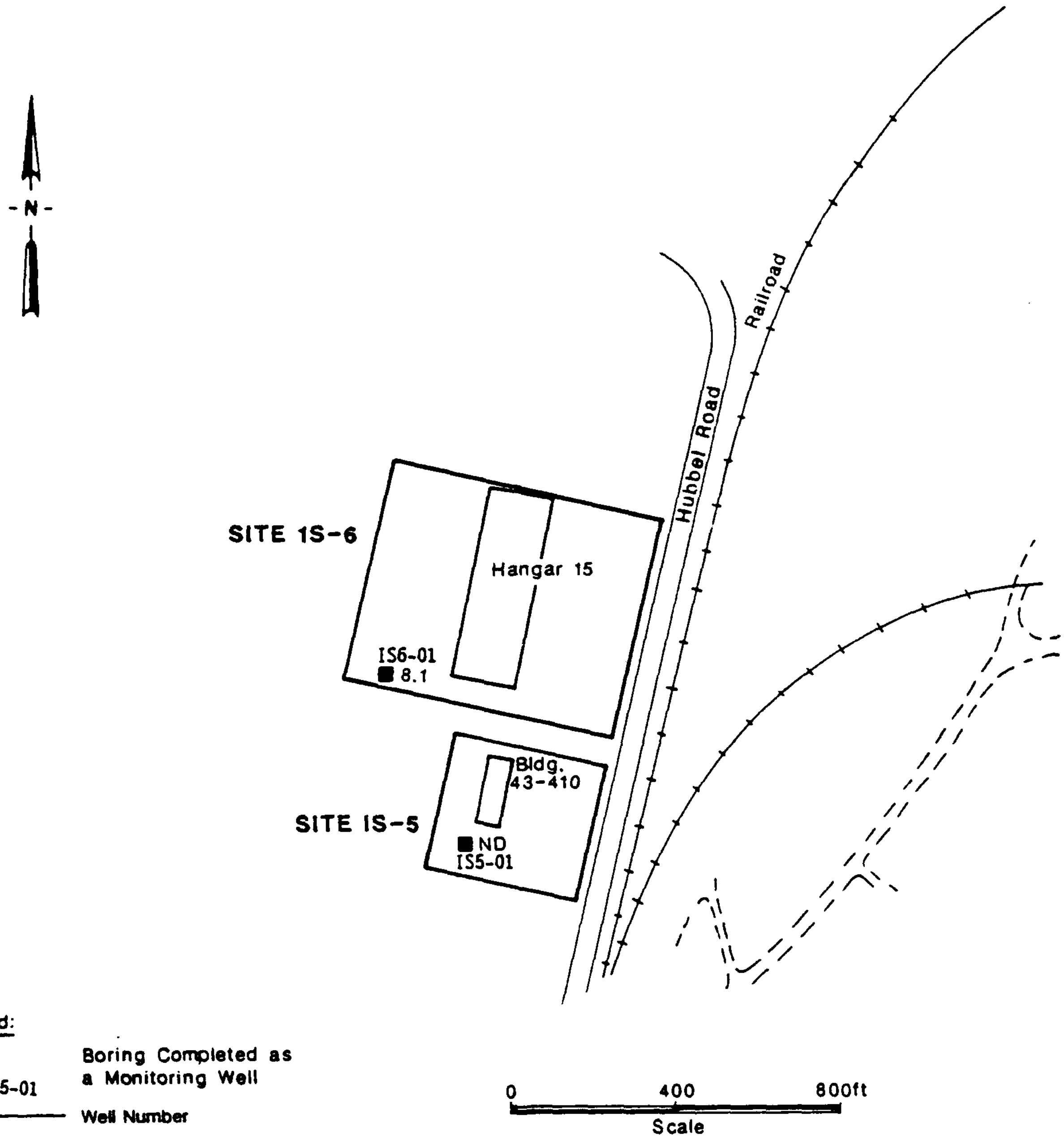
- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: ug/L
  - ND Non-Detected

Note: Water sample concentrations not associated with a depth.

CHLOROFORM CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.25



Legend:

IS5-01 — Boring Completed as a Monitoring Well

IS6-01 (Symbol) 10/300

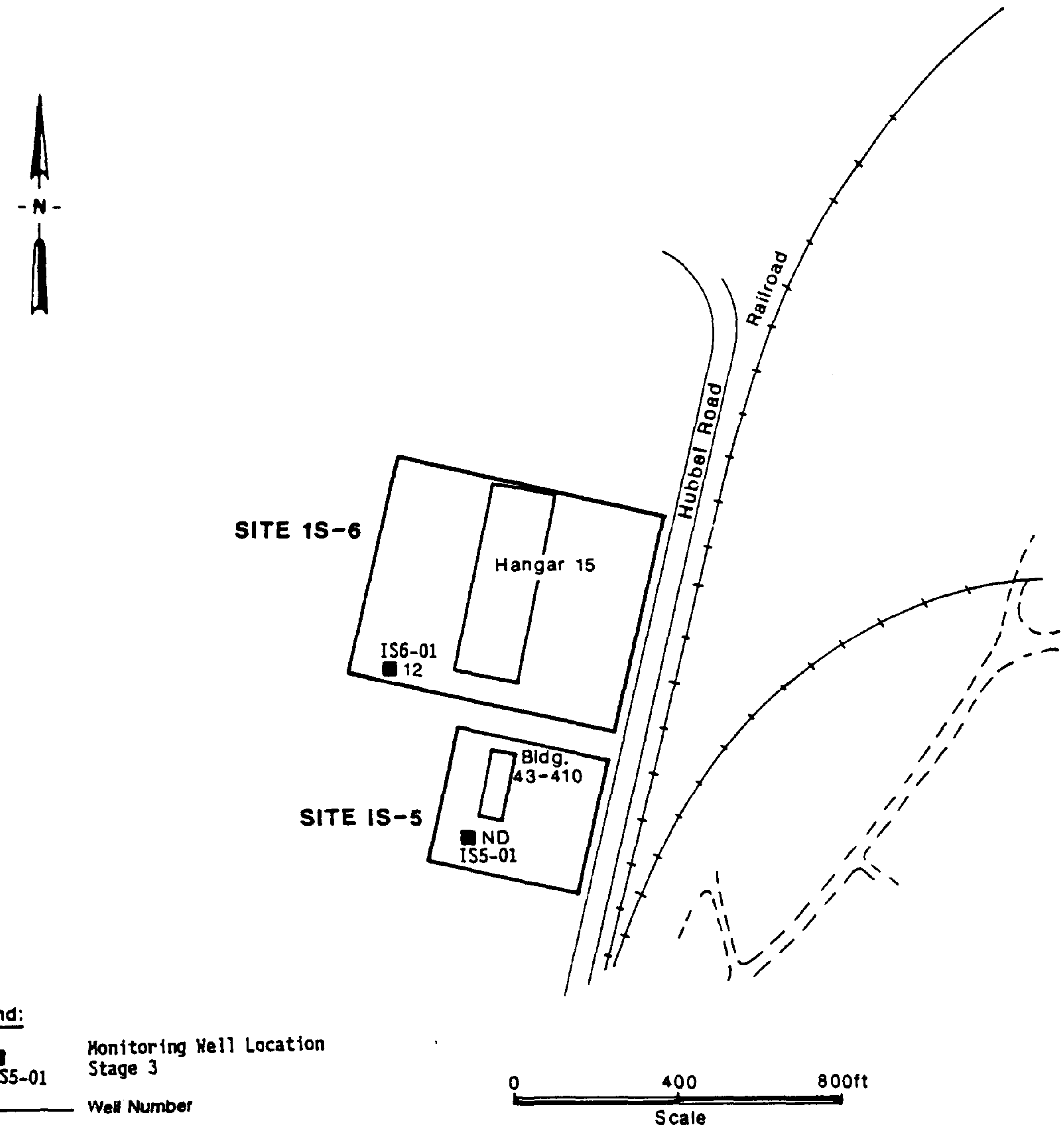
- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: µg/L
  - ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

TRICHLOROETHENE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.26



Legend:

IS5-01 — Monitoring Well Location Stage 3

IS6-01 (Symbol) 10/300

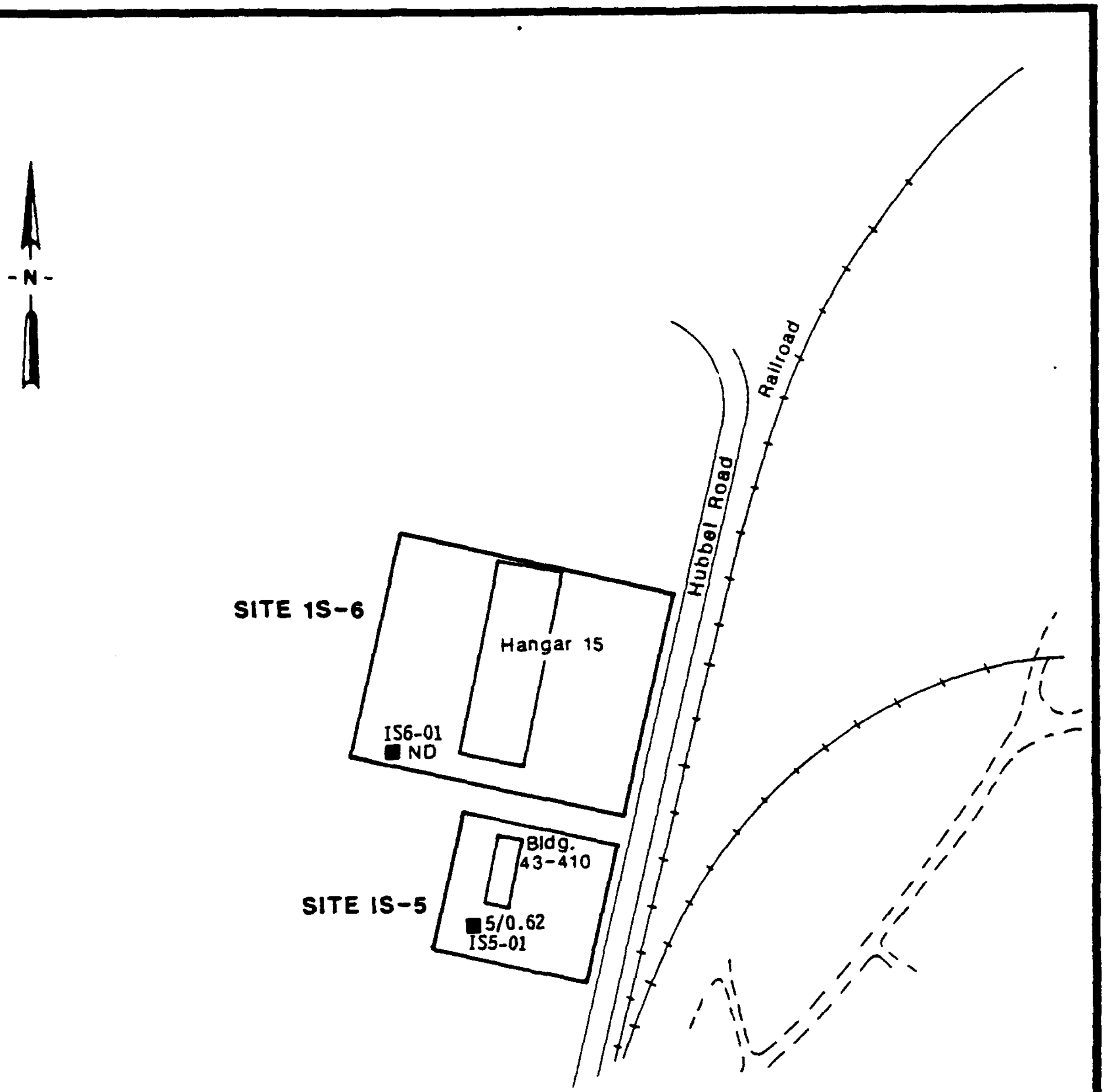
- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - [Soil: mg/kg
  - Water: µg/L
  - ND: Non-Detected]

Note: Water sample concentrations not associated with a depth.

TETRACHLOROETHENE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.27



0 400 800ft
Scale

Legend:

IS5-01 — Monitoring Well Location Stage 3

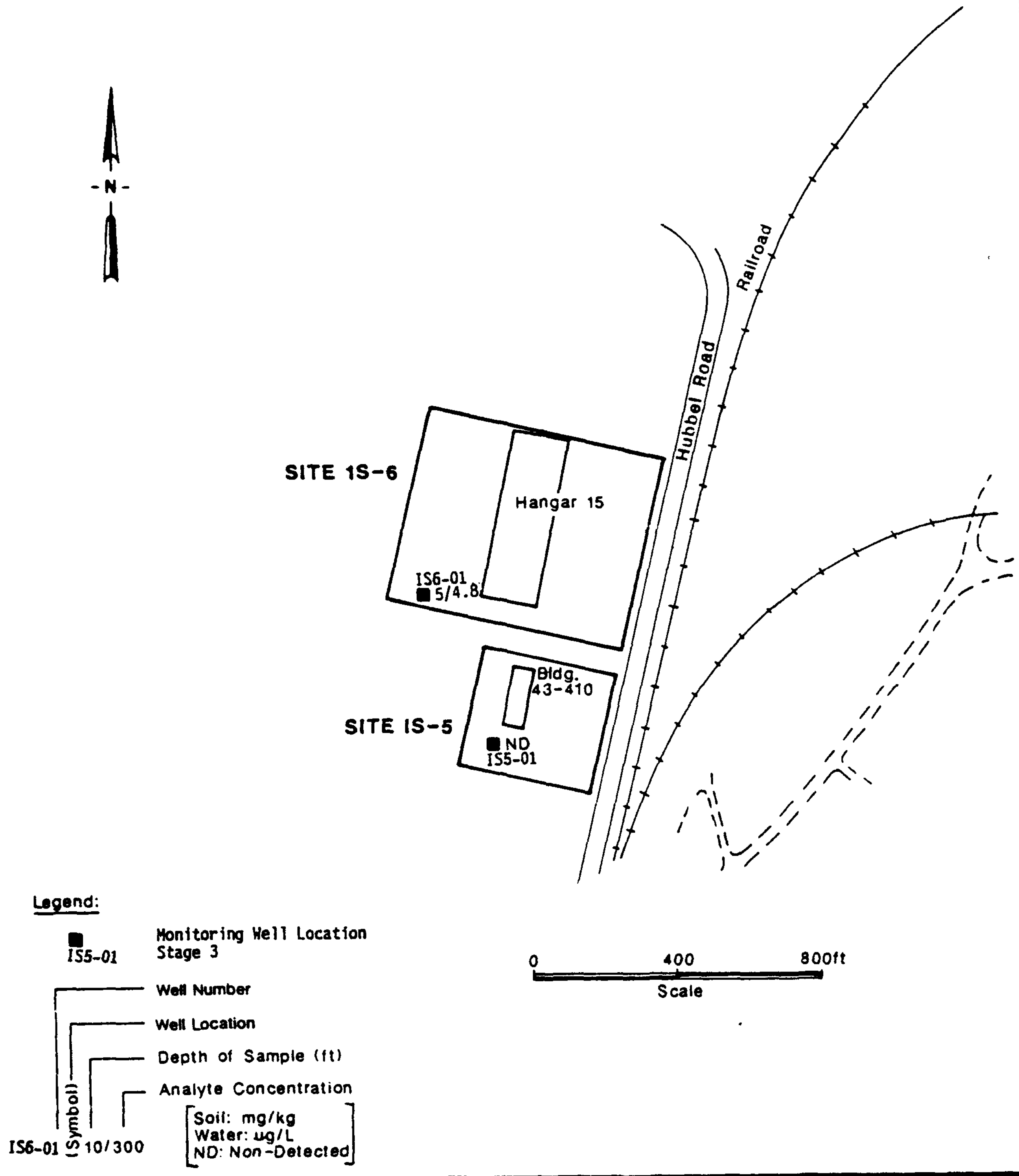
IS6-01 (Symbol) 10/300

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: ug/L
  - ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

BIS(2-ETHYLHEXYL) PHTHALATE CONCENTRATION SITES IS-5 & IS-6

IRP Stage 3 RI/FS **Elmendorf AFB, AK**	**Figure** 4.2.8.28

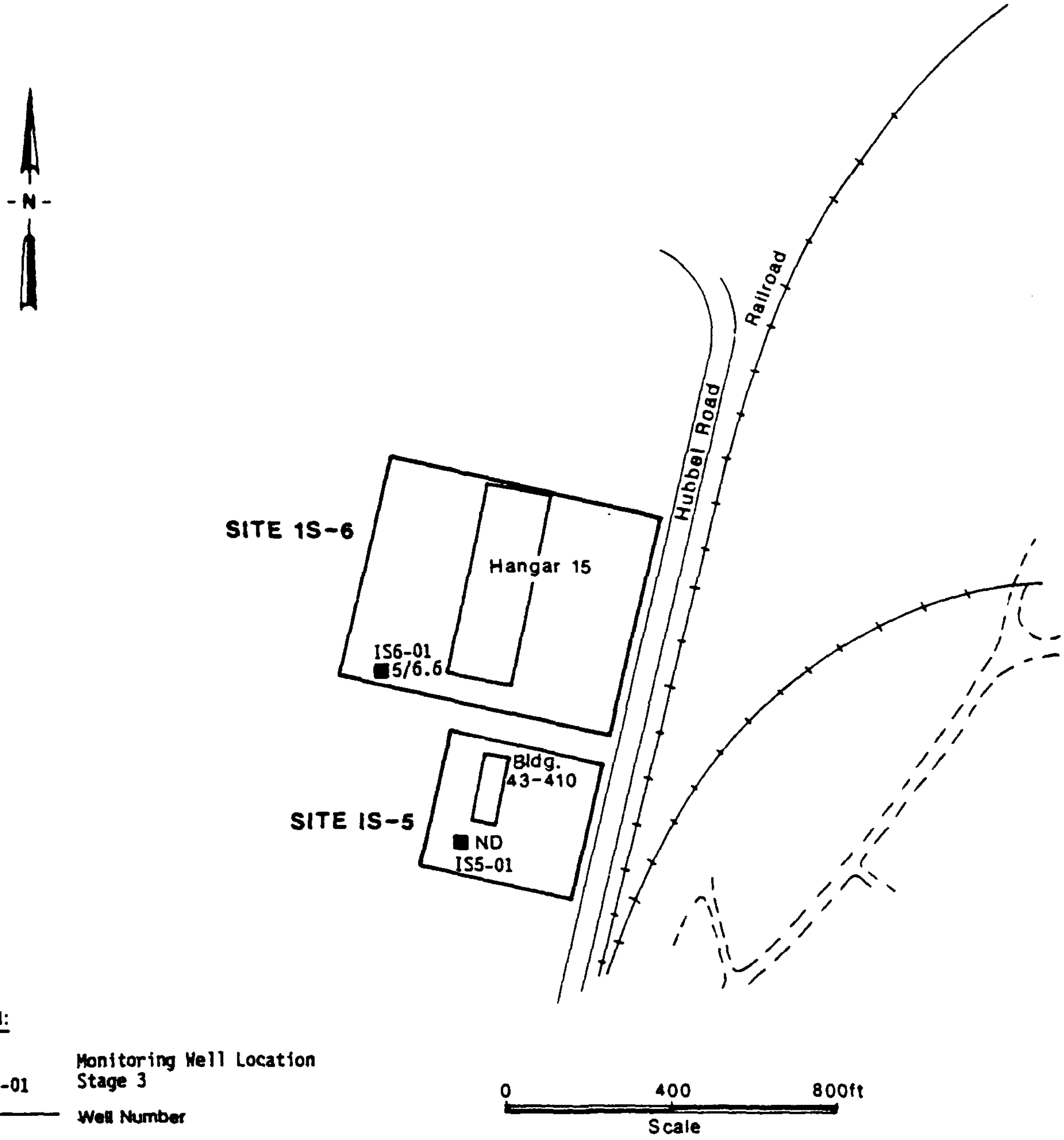


Note: Water sample concentrations not associated with a depth.

PHENANTHRENE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.29



Legend:

IS5-01 — Monitoring Well Location Stage 3

IS6-01 (Symbol) 10/300

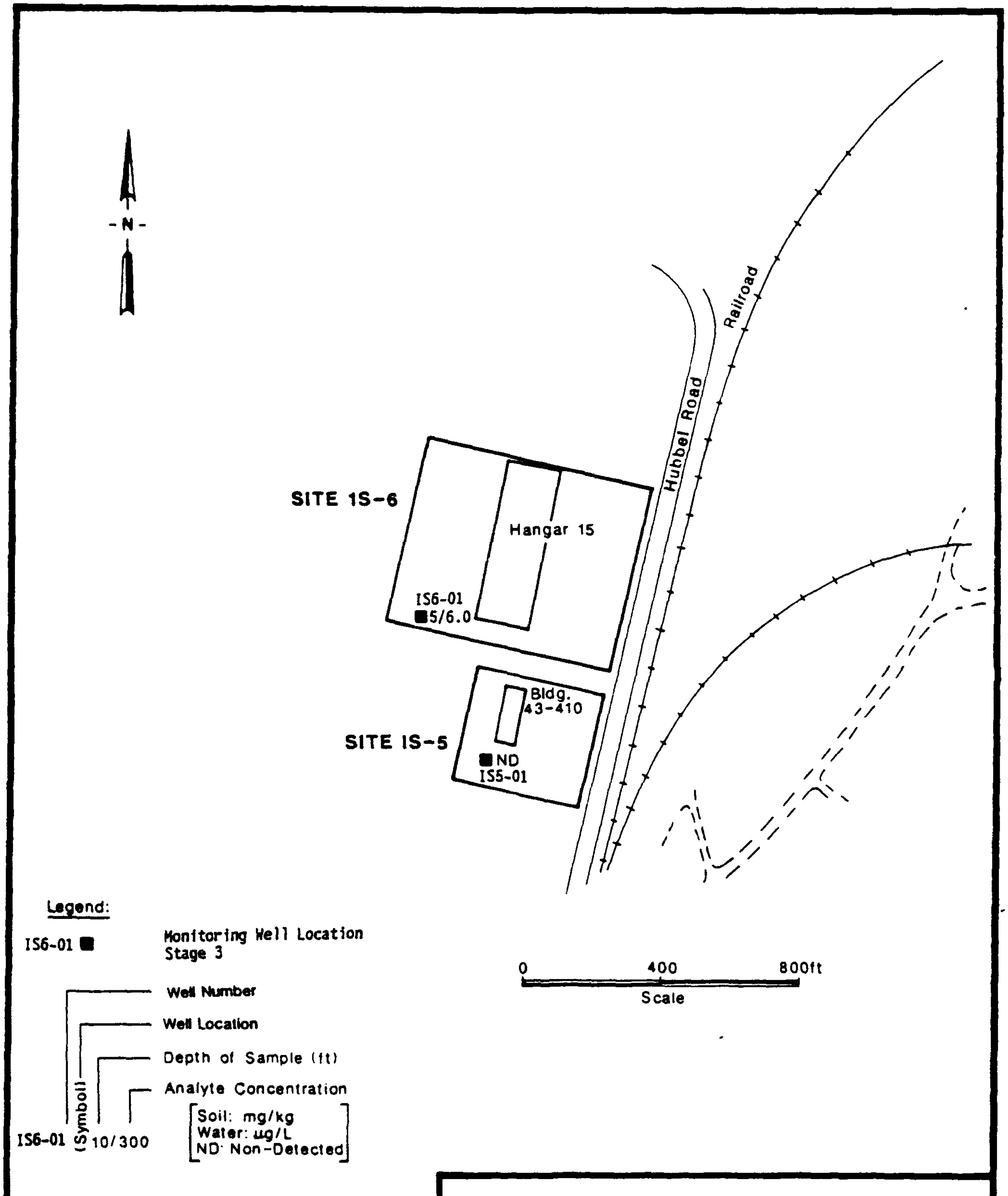
- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: µg/L
  - ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

FLUORANTHENE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

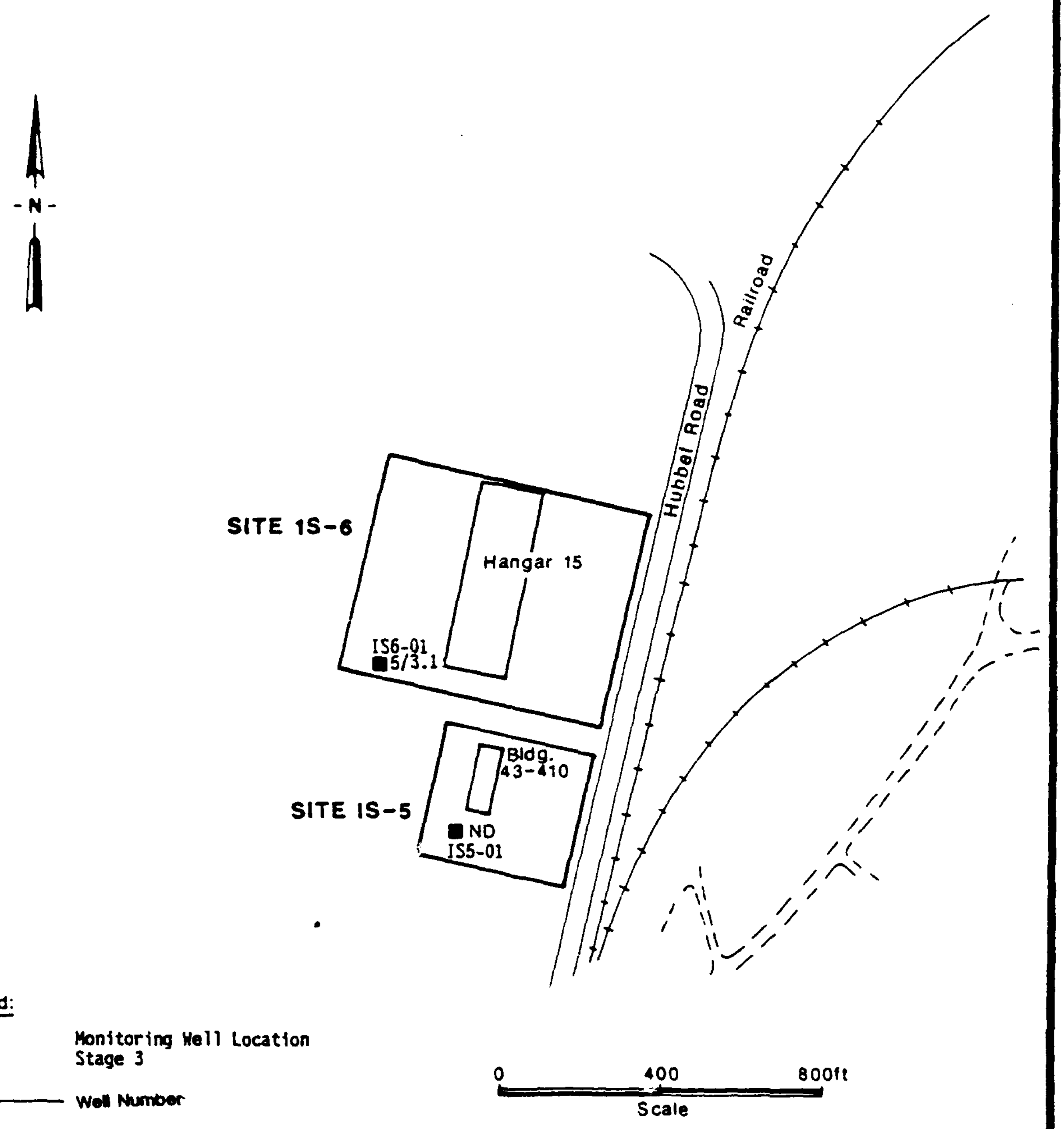
Figure
4.2.8.30



Note: Water sample concentrations not associated with a depth.

PYRENE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.8.31



Legend:

IS6-01 ■ Monitoring Well Location Stage 3

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration

IS6-01 (Symbol) 10/300

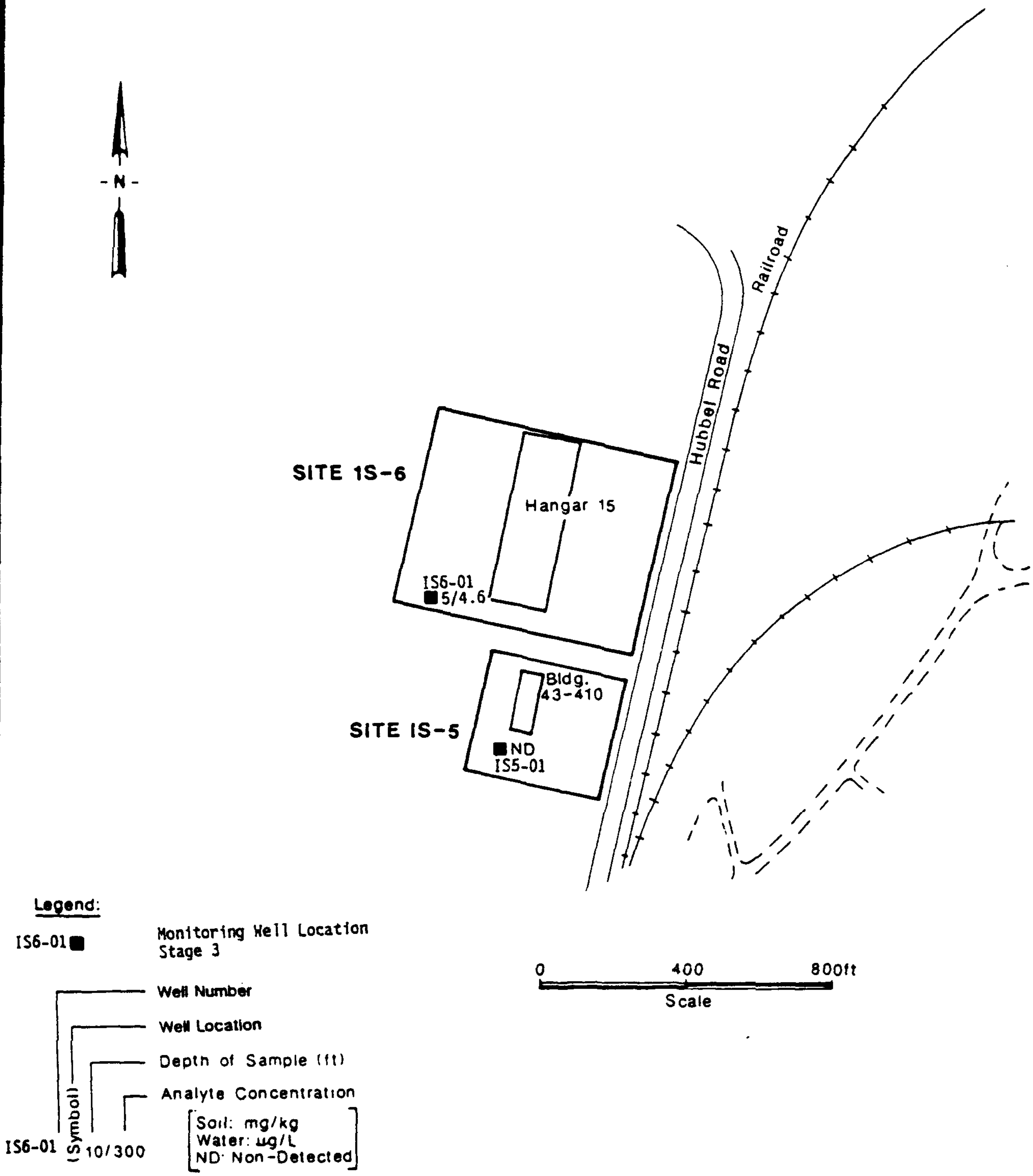
[Soil: mg/kg
Water: µg/L
ND: Non-Detected]

Note: Water sample concentrations not associated with a depth.

BENZO(a)ANTHRACENE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.32

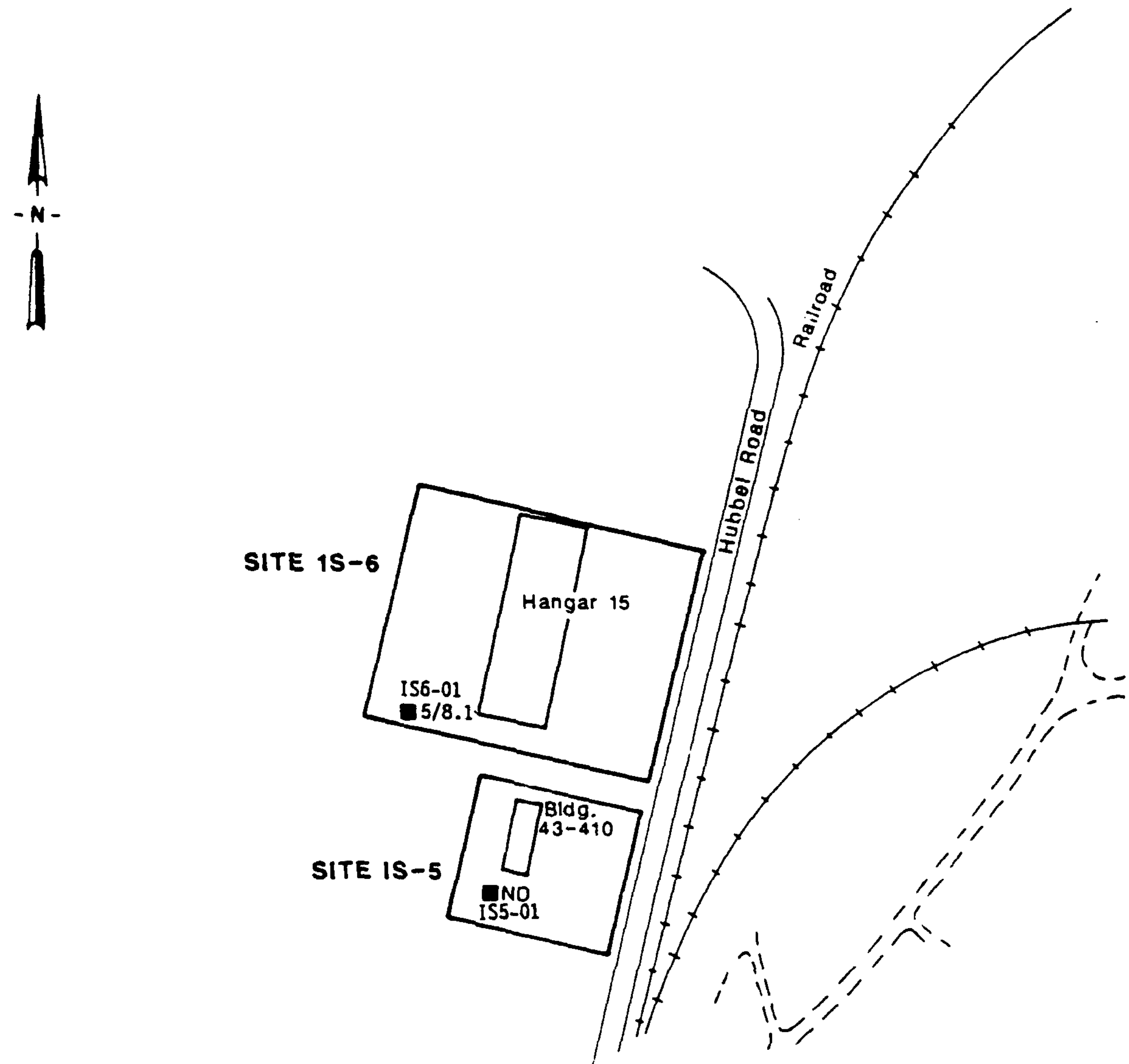


Note: Water sample concentrations not associated with a depth.

CHRYSENE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.33



Legend:

IS6-01 ■ Monitoring Well Location Stage 3

0 400 800ft
Scale

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration

IS6-01 (Symbol) 10/300

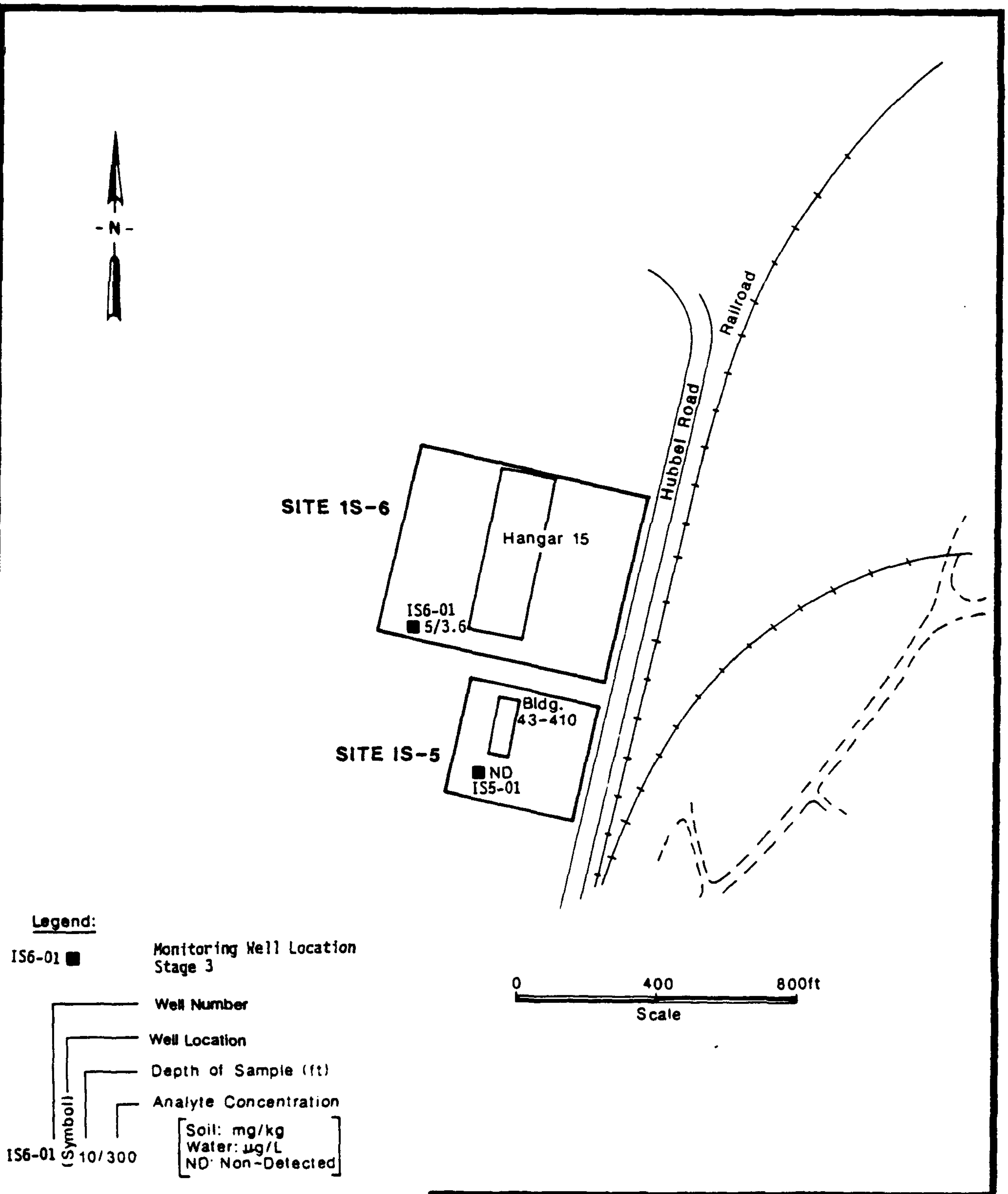
Soil: mg/kg
Water: µg/L
ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

BENZO(k)FLUORANTHENE
CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.34

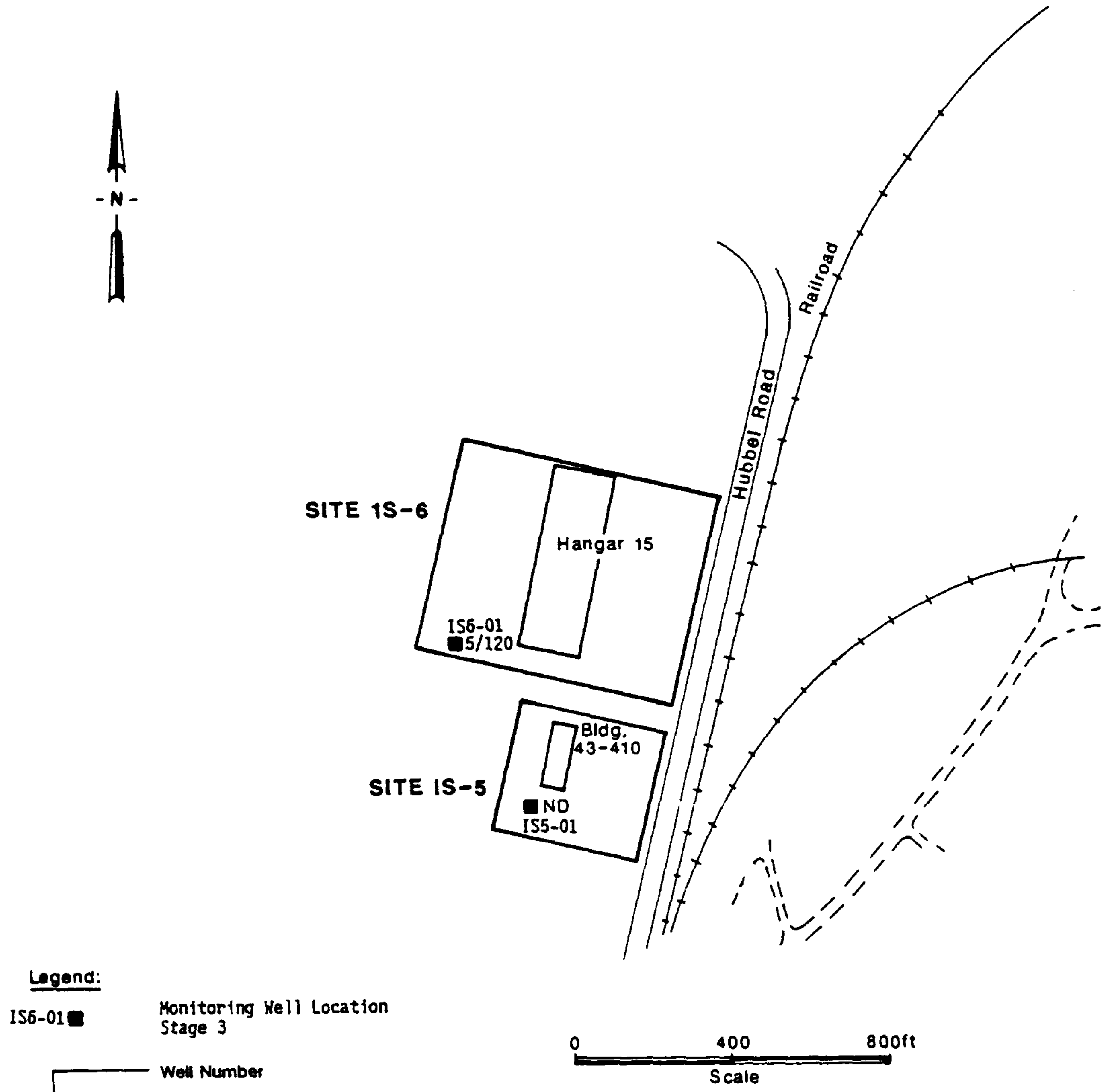


Note: Water sample concentrations not associated with a depth.

BENZO(a)PYRENE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.35



Legend:

IS6-01 ■ Monitoring Well Location Stage 3

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration

IS6-01 (Symbol) 10/300

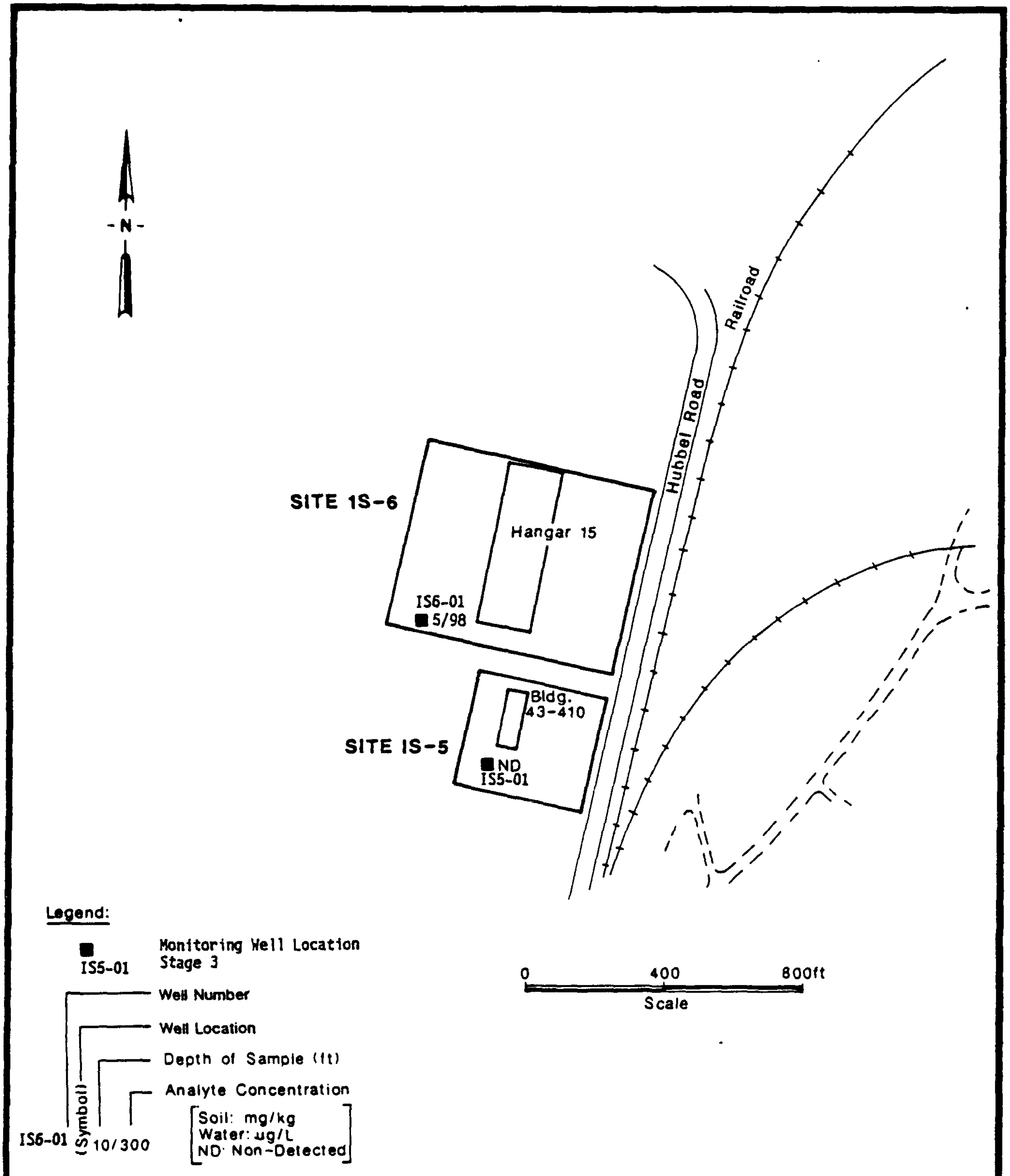
[Soil: mg/kg
Water: µg/L
ND: Non-Detected]

Note: Water sample concentrations not associated with a depth.

2-PICOLINE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.36

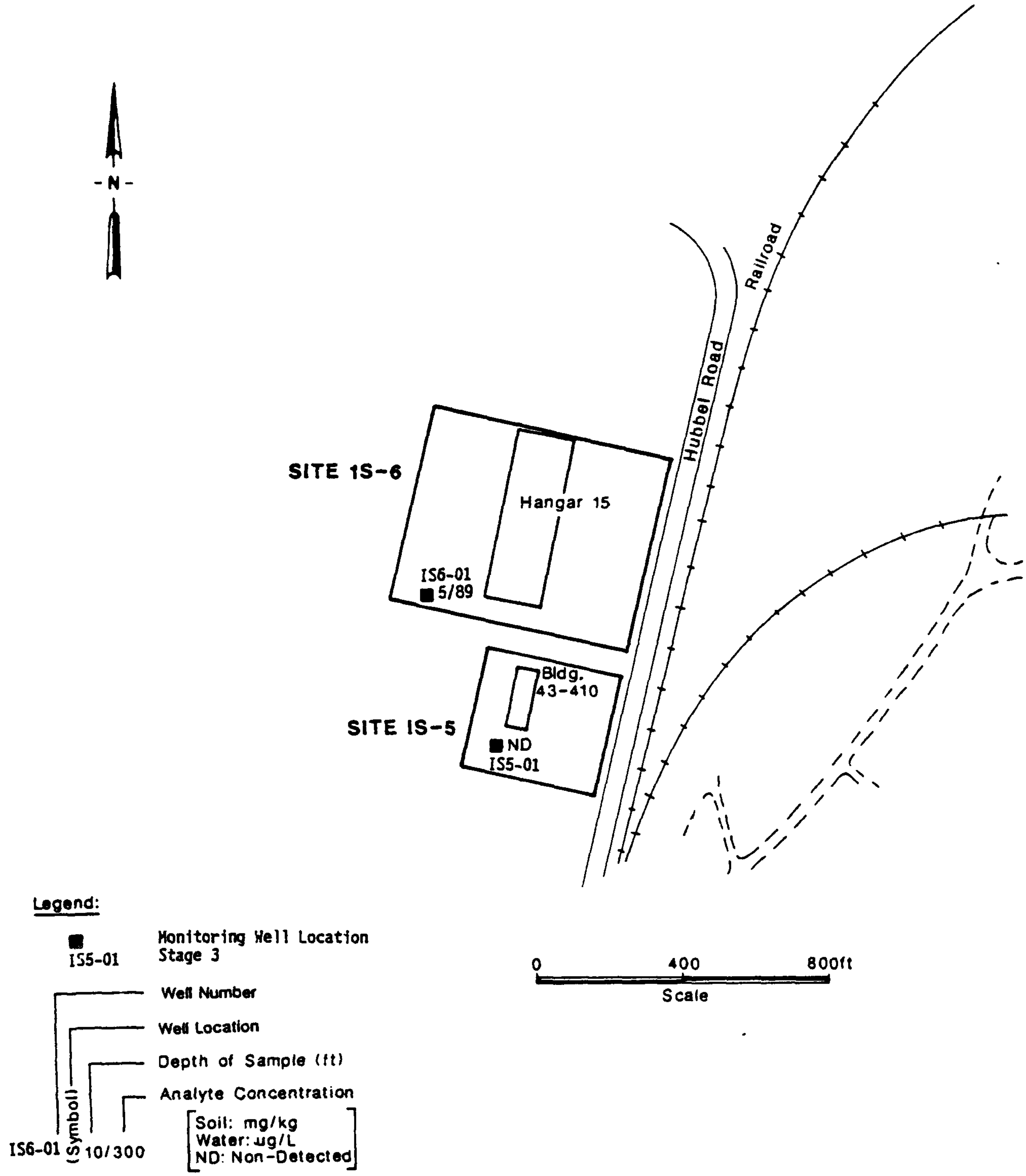


Note: Water sample concentrations not associated with a depth.

PRONAMIDE CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.37

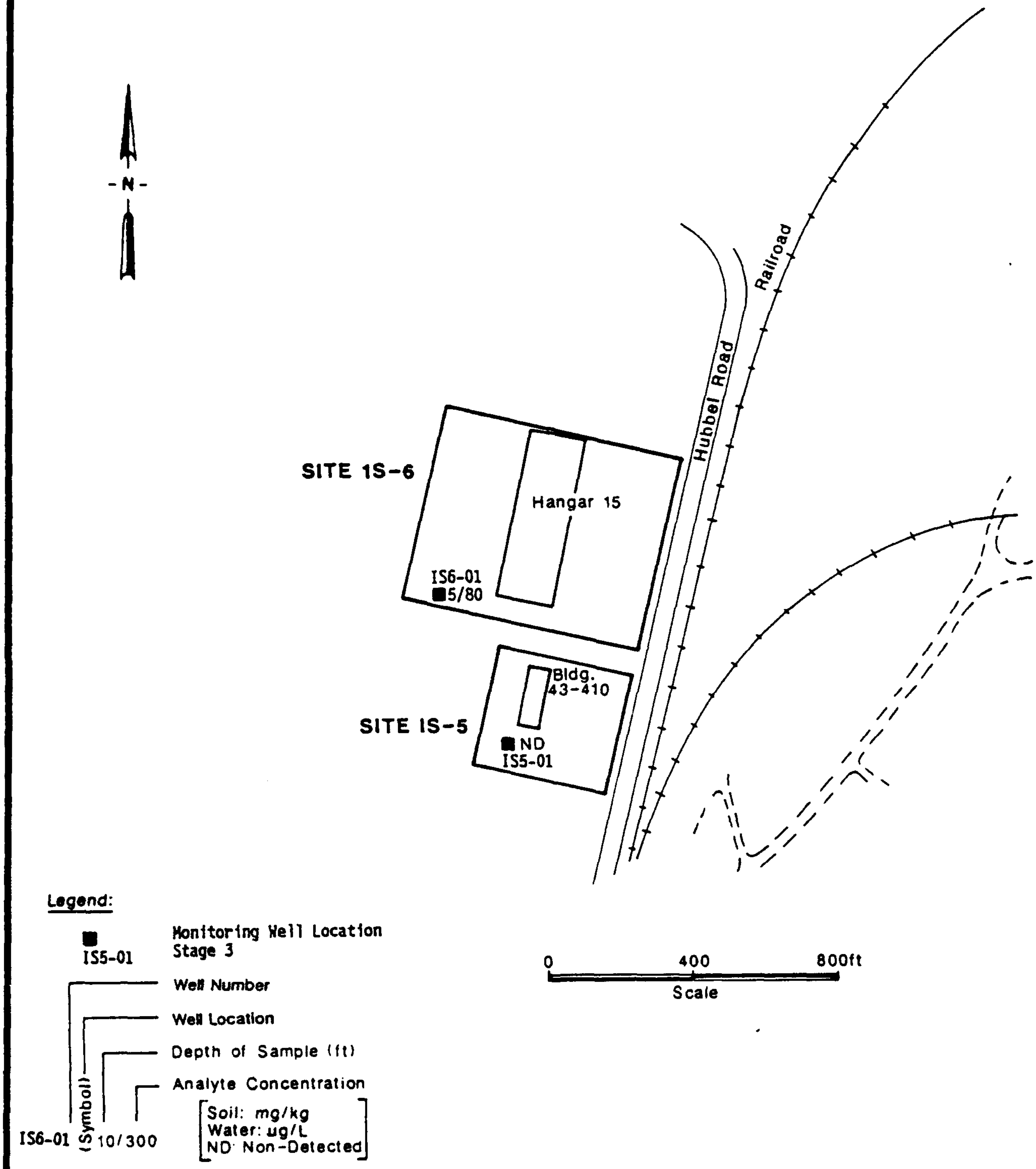


Note: Water sample concentrations not associated with a depth.

1,2,4,5-TETRACHLORO-BENZENE
CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.38

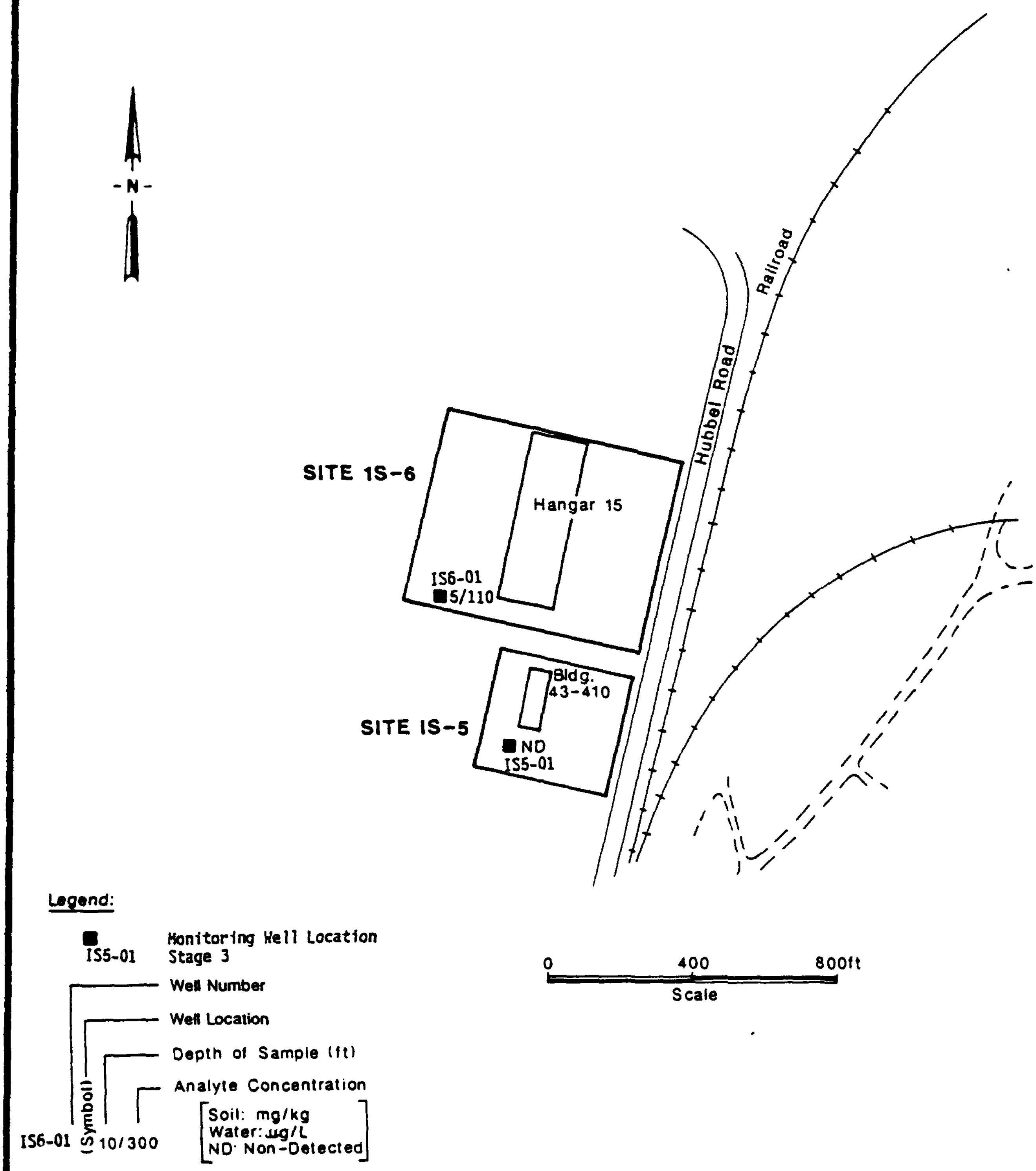


Note: Water sample concentrations not associated with a depth.

2,6-DICHLOROPHENOL CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.39

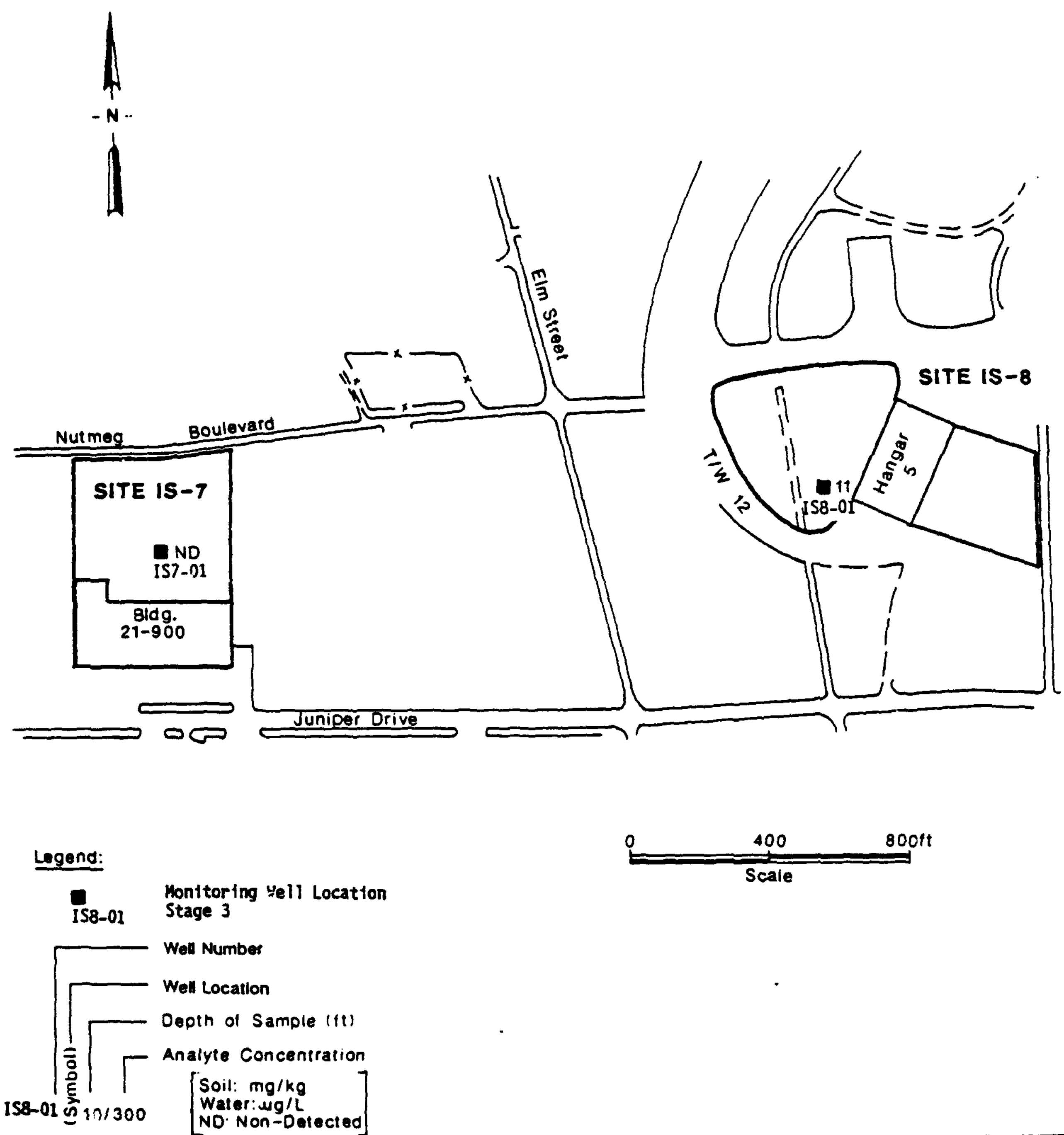


Note: Water sample concentrations not associated with a depth.

2-METHYLPHENOL CONCENTRATION
SITES IS-5 & IS-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.40

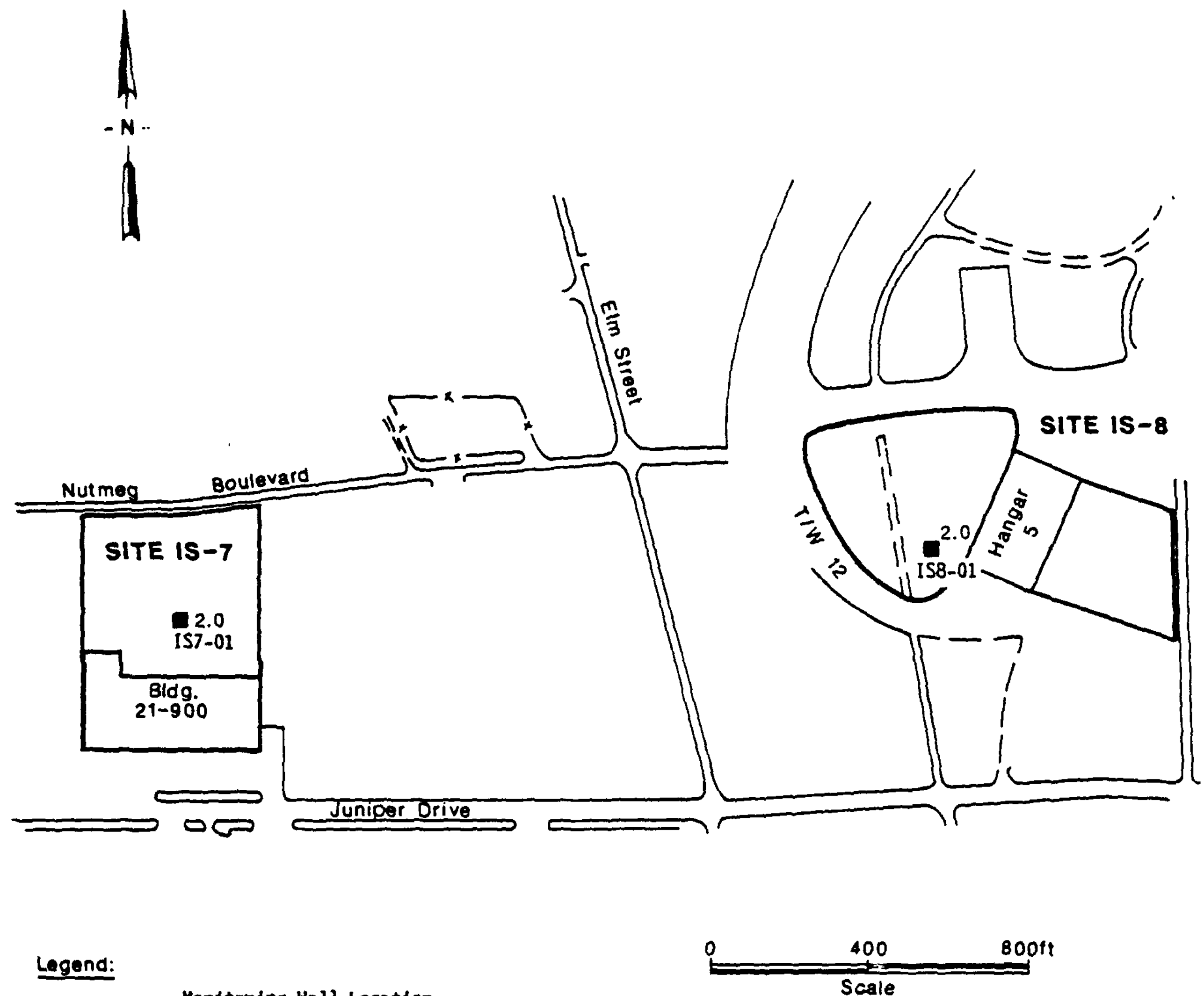


Note: water sample concentrations not associated with a depth.

TOLUENE
CONCENTRATION
SITES IS-7 & IS-8

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.8.41



Legend:

IS7-01 — Monitoring Well Location Stage 3

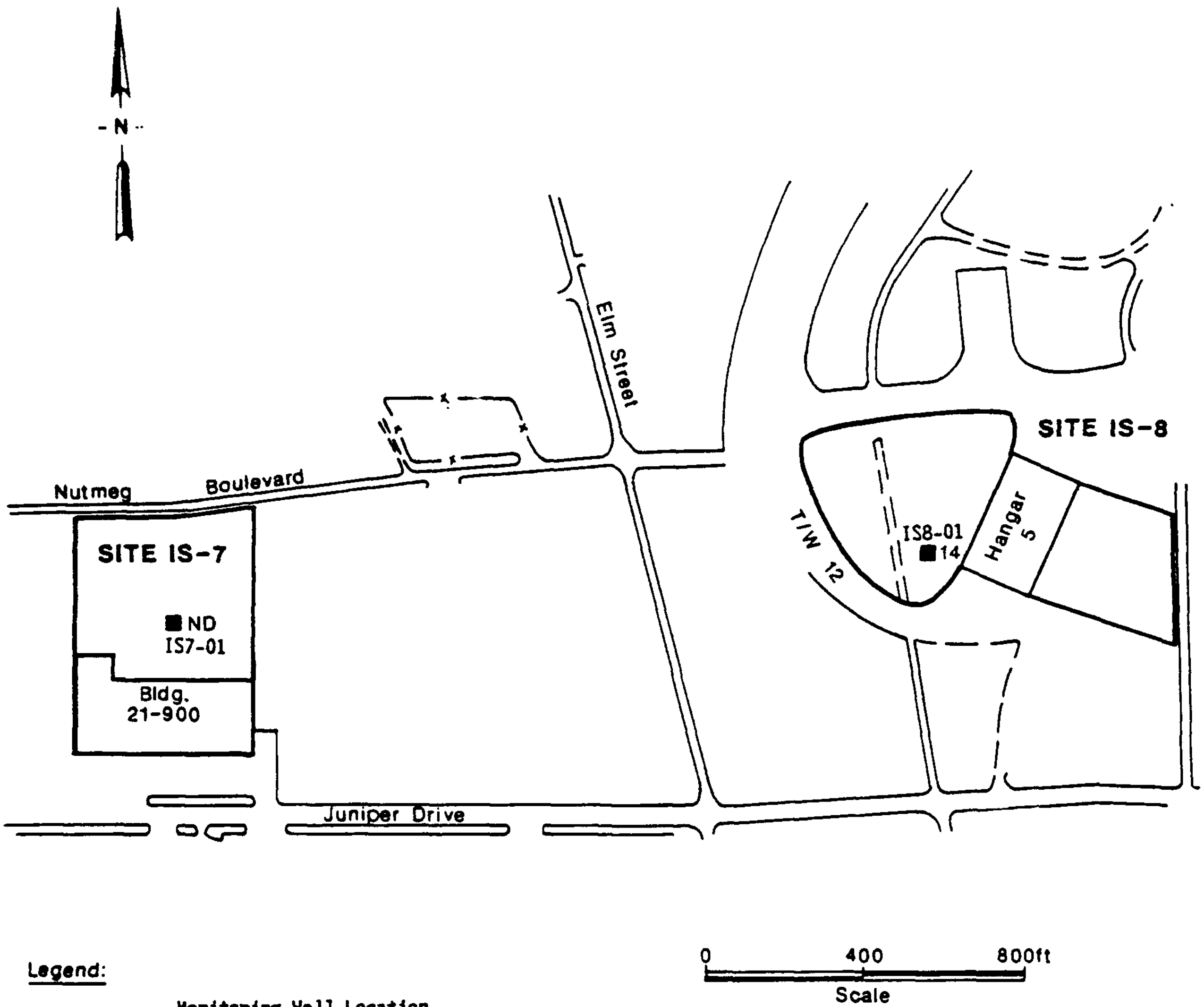
IS7-01 (Symbol) 10/300

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: mg/L
  - ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

TOTAL PETROLEUM HYDROCARBON CONCENTRATION SITES IS-7 & IS-8

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.8.42



Legend:

IS7-01 — Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

IS8-01 (Symbol) 10/300

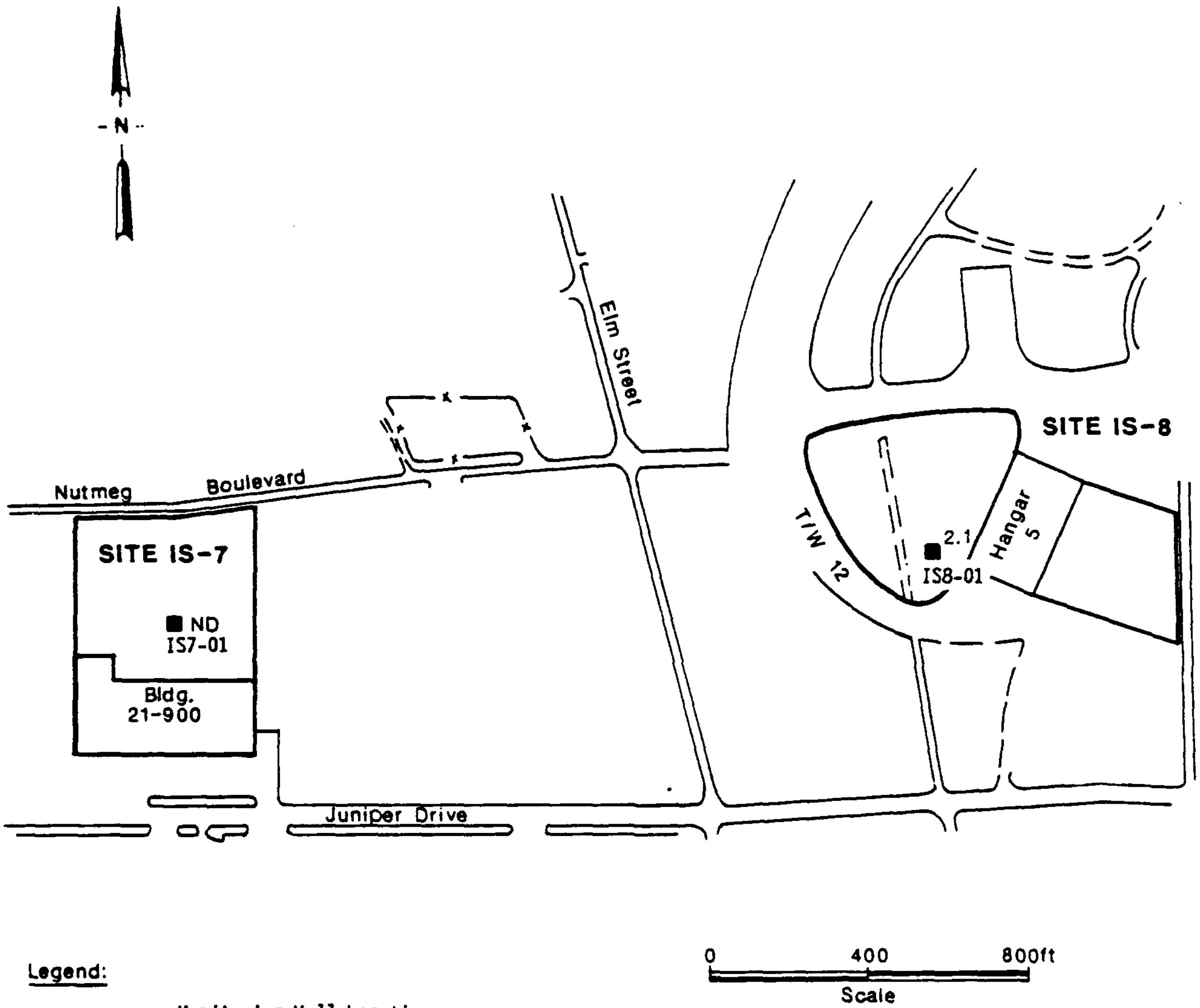
[Soil: mg/kg
Water: µg/L
ND: Non-Detected]

Note: Water sample concentrations not associated with a depth.

4-METHYL-2-PENTANONE CONCENTRATION SITES IS-7 & IS-8

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.43



Legend:

IS7-01 — Monitoring Well Location Stage 3

IS8-01 (Symbol) 10/300

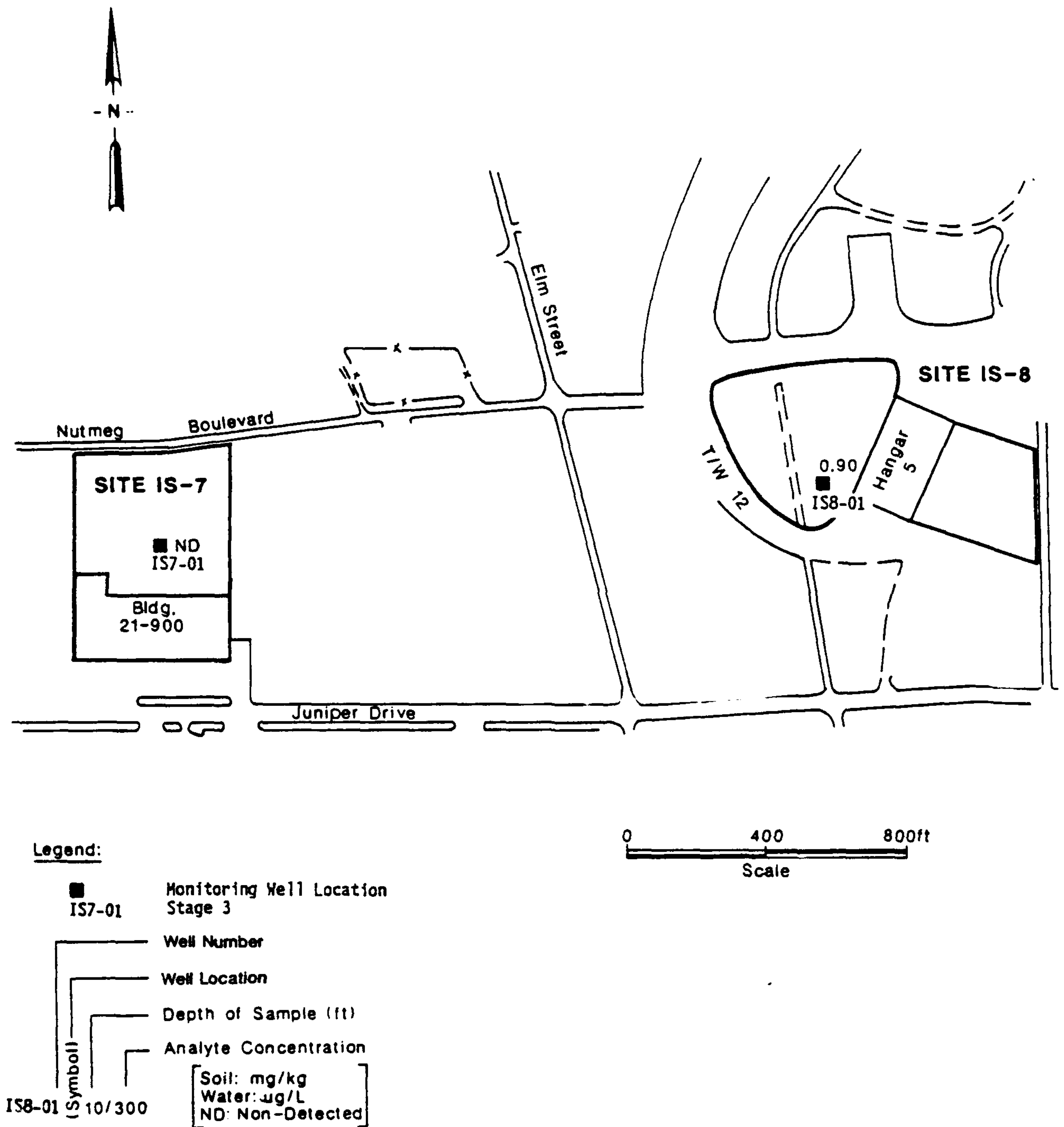
- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: ug/L
  - ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

1,1-DICHLOROETHANE
CONCENTRATION
SITES IS-7 & IS-8

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.44

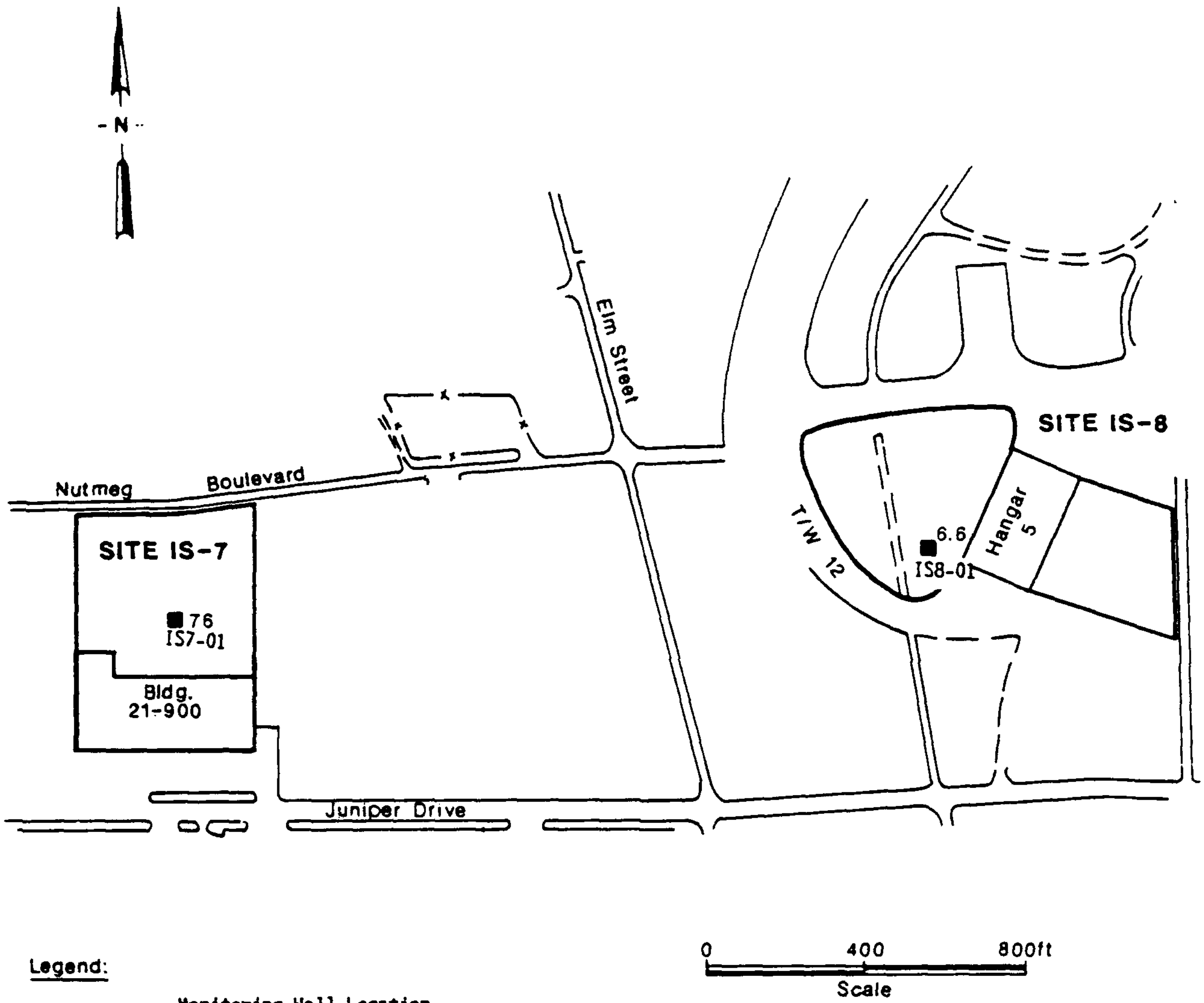


Note: Water sample concentrations not associated with a depth.

1,1,1-TRICHLOROETHANE CONCENTRATION SITES IS-7 & IS-8

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.45



Legend:

■ IS7-01 — Monitoring Well Location Stage 3

IS8-01 (Symbol) 10/300

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: µg/L
  - ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

TRICHLOROETHENE CONCENTRATION SITES IS-7 & IS-8

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.8.46

Table 4.2.8.1. Field Parameters Sites IS-1 Through IS-8.

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
IS-01	8/18/88	7.0	620	7.08	396	No odor or sheen
W-18	8/18/88	8.5	590	7.22	404	Pure product* slight odor
W-19	8/18/88	6.0	450	7.26	404	No odor or sheen
IS-02	8/17/88	6.8	330	7.41	236	No odor or sheen
IS-03	8/18/88	5.9	515	7.05	324	No odor or sheen
IS-04	8/18/88	7.0	505	7.23	224	No odor or sheen
IS-05	8/17/88	5.8	190	7.28	104	No odor or sheen
IS-06	8/17/88	5.5	250	7.12	156	No odor or sheen
IS-07	8/17/88	8.5	312	7.14	148	No odor or sheen
IS-08	8/17/88	8.5	395	7.10	272	Slight POL Odor, sheen

* Note - The product thickness in the first bailer was approximately 1/2 inch. Subsequent bailers had decreasing product thickness.

Table 4.2.8.2 Requested Analyses for Laboratory Samples at Sites IS-1 Through IS-8.

SOIL

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
6010	ICP Screen (25 metals)
7471	Mercury
8080	Organochlorine Pesticides and PCBs
8240	Volatile Organic Compounds
8270	Semi-volatile Organic Compounds
160.3	Soil Moisture Content

WATER

Test Number	Analysis
300	Common Anions
418.1	Petroleum Hydrocarbons
200.7	ICP Screen (total and dissolved)
206.2	Arsenic (total and dissolved)
239.2	Lead (total and dissolved)
245.1	Mercury (total and dissolved)
270.2	Selenium (total and dissolved)
601	Purgeable Halocarbons
624	Nonhalogenated Volatile Organics
602	Purgeable Aromatics
608	Organochlorine Pesticides and PCBs
625	Extractable Priority Pollutants

Table 4.2.8.3

Analytical Results - Site IS-1

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-19 0687-NG-042 001318-0005	GN-88-0001	W-19 GN840289	W-19 W-19-7	W-19 W-19/54	IS1-01 0687-NG-033 001318-0007	GN-88-0003	IS1-01 5'-6.5' 0687-SO-033-GS-88-0001 001075-0001	IS1-01 31'-32.5' 0687-SO-033-GS-88-0002 001075-0002
1,1,1-Trichloroethane	EPA 601	ug/L	200	3.1				2.4				
1,1-Dichloroethane	EPA 601	ug/L		7.1				6.1	1.1			
2-Methylnaphthalene	Method 625	ug/L										
Aluminum	6010	mg/kg									10636	9800
Barium	6010	mg/kg									41	30
Benzene	EPA 602	ug/L	5.0									
Calcium	6010	mg/kg									5735	4454
Chromium	6010	mg/kg	50,000								22	20
Cobalt	6010	mg/kg									8	9
Copper	6010	mg/kg	1,850								23	21
Cyanide, Total	335.3	mg/L							0.02			
Dissolved Arsenic	206.2	mg/L	0.05						0.010			
Dissolved Barium	200.7	mg/L	1.0	0.030					0.17			
Dissolved Cadmium	200.7	mg/L	0.01									
Dissolved Calcium	200.7	mg/L		137.					169.			
Dissolved Cobalt	200.7	mg/L							0.01			
Dissolved Iron	200.7	mg/L	0.3						3.3			
Dissolved Magnesium	200.7	mg/L		14.					20.			
Dissolved Manganese	200.7	mg/L	0.05	1.7					6.7			
Dissolved Nickel	200.7	mg/L							0.01			
Dissolved Sodium	200.7	mg/L	250	4.4					20.			
Dissolved Zinc	200.7	mg/L	0.05						0.06			
Ethyl benzene	EPA 602	ug/L	700									
Iron	6010	mg/kg									20542	21158
LEAD	239.2	mg/L	0.3									
MOISTURE	GRAV.	%					29					
Magnesium	6010	mg/kg									7716	8686
Manganese	6010	mg/kg	11,000								500	423
Naphthalene	Method 625	ug/L										
Nickel	6010	mg/kg	500								25	29
OIL & GREASE	413.2	mg/L				1.7						
Recoverable Aluminum	200.7	mg/L		2.0					68.			
Recoverable Arsenic	206.2	mg/L	0.05						0.019			
Recoverable Barium	200.7	mg/L	1.0	0.052					0.93			
Recoverable Beryllium	200.7	mg/L	0.0000039						0.004			
Recoverable Cadmium	200.7	mg/L	0.01						0.005			
Recoverable Calcium	200.7	mg/L		142.					272.			
Recoverable Chromium	200.7	mg/L	0.05						0.10			
Recoverable Cobalt	200.7	mg/L		0.01					0.18			
Recoverable Copper	200.7	mg/L	1.0	0.016					1.1			
Recoverable Iron	200.7	mg/L	0.3	4.6					161.			
Recoverable Lead	239.2	mg/L	0.05	0.003					0.16			
Recoverable Magnesium	200.7	mg/L		15.					59.			
Recoverable Manganese	200.7	mg/L	0.05	2.5					27.			
Recoverable Nickel	200.7	mg/L		0.01					0.45			
Recoverable Potassium	200.7	mg/L							6.			
Recoverable Sodium	200.7	mg/L	250	4.8					15.			
Recoverable Vanadium	200.7	mg/L							0.34			
Recoverable Zinc	200.7	mg/L	5.0	0.02					0.55			
Sodium	6010	mg/kg									125	
Sulfate	300.0	mg/L	250						11.			
TOC	415.1	mg/L				1						
TOX	9020	ug/L				52						
Toluene	EPA 602	ug/L	2000									
Total Mercury	245.1	mg/L	0.002						0.007			
Total Petroleum Hydrocarbons	EPA 418.1										907	212
Total Solids	160.3	%									95.9	89.8
Vanadium	6010	mg/kg	1,000								33	36
Zinc	6010	mg/kg	10,500								44	41
bis(2-Ethylhexyl)phthalate	Method 625	ug/L										
m-Xylene	EPA 602	ug/L	440									
o & p-Xylene(s)	EPA 602	ug/L	440									

Table 4.2.8.3

Analytical Results - Site IS-1

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-18 0687-NG-041 001318-0009	GW-88-0001	W-18 GN840288	W-18 W-18-7	W-18 W-18/49	W-18(fqc) W-18/51
1,1,1-Trichloroethane	EPA 601	ug/L	200						
1,1-Dichloroethane	EPA 601	ug/L						1.4	1.3
2-Methylnaphthalene	Method 625	ug/L		500.					
Aluminum	6010	mg/kg							
Barium	6010	mg/kg							
Benzene	EPA 602	ug/L	5.0	35.					
Calcium	6010	mg/kg							
Chromium	6010	mg/kg	50,000						
Cobalt	6010	mg/kg							
Copper	6010	mg/kg	1,850						
Cyanide, Total	335.3	mg/L							
Dissolved Arsenic	206.2	mg/L	0.05	0.010					
Dissolved Barium	200.7	mg/L	1.0	0.042					
Dissolved Cadmium	200.7	mg/L	0.01	0.013					
Dissolved Calcium	200.7	mg/L		166.					
Dissolved Cobalt	200.7	mg/L							
Dissolved Iron	200.7	mg/L	0.3	4.8					
Dissolved Magnesium	200.7	mg/L		18.					
Dissolved Manganese	200.7	mg/L	0.05	4.5					
Dissolved Nickel	200.7	mg/L							
Dissolved Sodium	200.7	mg/L	250	6.0					
Dissolved Zinc	200.7	mg/L	0.05						
Ethyl benzene	EPA 602	ug/L	700	250.					
Iron	6010	mg/kg							
LEAD	239.2	mg/L	0.3			0.020			
MOISTURE	GRAV.	%					27		
Magnesium	6010	mg/kg							
Manganese	6010	mg/kg	11,000						
Naphthalene	Method 625	ug/L		280.					
Nickel	6010	mg/kg	500						
OIL & GREASE	413.2	mg/L				2.5	330		
Recoverable Aluminum	200.7	mg/L		0.44					
Recoverable Arsenic	206.2	mg/L	0.05	0.008					
Recoverable Barium	200.7	mg/L	1.0	0.044					
Recoverable Beryllium	200.7	mg/L	0.0000039						
Recoverable Cadmium	200.7	mg/L	0.01						
Recoverable Calcium	200.7	mg/L		164.					
Recoverable Chromium	200.7	mg/L	0.05						
Recoverable Cobalt	200.7	mg/L							
Recoverable Copper	200.7	mg/L	1.0	0.009					
Recoverable Iron	200.7	mg/L	0.3	5.0					
Recoverable Lead	239.2	mg/L	0.05	0.002					
Recoverable Magnesium	200.7	mg/L		17.					
Recoverable Manganese	200.7	mg/L	0.05	4.4					
Recoverable Nickel	200.7	mg/L		0.01					
Recoverable Potassium	200.7	mg/L							
Recoverable Sodium	200.7	mg/L	250	5.3					
Recoverable Vanadium	200.7	mg/L							
Recoverable Zinc	200.7	mg/L	5.0	0.01					
Sodium	6010	mg/kg							
Sulfate	300.0	mg/L	250	9.2					
TOC	415.1	mg/L				6			
TOX	9020	ug/L				150			
Toluene	EPA 602	ug/L	2000	460.					
Total Mercury	245.1	mg/L	0.002						
Total Petroleum Hydrocarbons	EPA 418.1			78.					
Total Solids	160.3	%							
Vanadium	6010	mg/kg	1,000						
Zinc	6010	mg/kg	10,500						
bis(2-Ethylhexyl)phthalate	Method 625	ug/L		720.					
m-Xylene	EPA 602	ug/L	440	530.					
o & p-Xylene(s)	EPA 602	ug/L	440	520.					

Table 4.2.8.3

Analytical Results - Site IS-2

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	IS2-01 0687-NG-034,GN-88-0003 001302-0003	IS2-01 10'-11.5' 0687-SO-034 GS-88-0001 001026-0001	IS2-01 30'-31.5' 0687-SO-034 GS-88-0002 001026-0006
Aluminum	6010	mg/kg			12893	10757
Barium	6010	mg/kg			37	44
Beryllium	6010	mg/kg			0.2	0.2
Calcium	6010	mg/kg			4442	5379
Chloride	300.0	mg/L	250	19.		
Chromium	6010	mg/kg	50,000		26	23
Cobalt	6010	mg/kg			10	10
Copper	6010	mg/kg	1,850		21	23
Cyanide, Total	335.3	mg/L		0.02		
Dissolved Barium	200.7	mg/L	1.0	0.16		
Dissolved Calcium	200.7	mg/L		89.		
Dissolved Magnesium	200.7	mg/L		12.		
Dissolved Manganese	200.7	mg/L	0.05	0.009		
Dissolved Sodium	200.7	mg/L	250	20.		
Iron	6010	mg/kg			24160	22832
Magnesium	6010	mg/kg			9534	7574
Manganese	6010	mg/kg	11,000		531	494
Nickel	6010	mg/kg			31	27
Nitrate as N	300.0	mg/L	10	4.1		
Potassium	6010	mg/kg			542	
Recoverable Aluminum	200.7	mg/L		80.		
Recoverable Arsenic	206.2	mg/L	0.05	0.010		
Recoverable Barium	200.7	mg/L	1.0	1.3		
Recoverable Calcium	200.7	mg/L		147.		
Recoverable Chromium	200.7	mg/L	0.05	0.12		
Recoverable Cobalt	200.7	mg/L		0.26		
Recoverable Copper	200.7	mg/L	1.0	0.69		
Recoverable Iron	200.7	mg/L	0.3	182.		
Recoverable Lead	239.2	mg/L	0.05	0.004		
Recoverable Magnesium	200.7	mg/L		55.		
Recoverable Manganese	200.7	mg/L	0.05	18.		
Recoverable Nickel	200.7	mg/L		0.58		
Recoverable Potassium	200.7	mg/L		6.		
Recoverable Sodium	200.7	mg/L	250	14.		
Recoverable Vanadium	200.7	mg/L		0.30		
Recoverable Zinc	200.7	mg/L	5.0	0.51		
Sodium	6010	mg/kg			401	154
Sulfate	300.0	mg/L	250	12.		
Total Mercury	245.1	mg/L	0.002	0.0032		
Total Petroleum Hydrocarbons	EPA 418.1			0.7		
Total Solids	160.3	%			92.3	91.1
Vanadium	6010	mg/kg	1,000		44	41
Zinc	6010	mg/kg	10,500		46	43

Table 4.2.8.3

Analytical Results - Site IS-3

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	IS3-01 0687-WG-035 GW-88-0003 001318-0003	IS3-01 15'-16.5' 0687-SO-035 GS-88-0001 001043-0003	IS3-01 45'-46.5' 0687-SO-035 GS-88-0002 001043-0004
Aluminum	6010	mg/kg			10996	10616
Barium	6010	mg/kg			47	41
Beryllium	6010	mg/kg			0.2	
Calcium	6010	mg/kg			3942	6393
Chromium	6010	mg/kg	50,000		24	22
Cobalt	6010	mg/kg			9	9
Copper	6010	mg/kg	1,850		26	22
Cyanide, Total	335.3	mg/L		0.01		
Dissolved Barium	200.7	mg/L	1.0	0.13		
Dissolved Calcium	200.7	mg/L		157.		
Dissolved Magnesium	200.7	mg/L		18.		
Dissolved Manganese	200.7	mg/L	0.05	4.5		
Dissolved Sodium	200.7	mg/L	250	12.		
Dissolved Zinc	200.7	mg/L	5.0	0.05		
Iron	6010	mg/kg			23963	20890
Magnesium	6010	mg/kg			8299	7877
Manganese	6010	mg/kg	11,000		560	411
Nickel	6010	mg/kg			26	25
Nitrate as N	300.0	mg/L	10	6.4		
Potassium	6010	mg/kg			622	
Recoverable Aluminum	200.7	mg/L		65.		
Recoverable Arsenic	206.2	mg/L	0.05	0.010		
Recoverable Barium	200.7	mg/L	1.0	0.55		
Recoverable Beryllium	200.7	mg/L	0.0000039	0.002		
Recoverable Calcium	200.7	mg/L		205.		
Recoverable Chromium	200.7	mg/L	0.05	0.11		
Recoverable Cobalt	200.7	mg/L		0.11		
Recoverable Copper	200.7	mg/L	1.0	0.62		
Recoverable Iron	200.7	mg/L	0.3	151.		
Recoverable Lead	239.2	mg/L	0.05	0.084		
Recoverable Magnesium	200.7	mg/L		54.		
Recoverable Manganese	200.7	mg/L	0.05	9.4		
Recoverable Nickel	200.7	mg/L		0.28		
Recoverable Potassium	200.7	mg/L		6.		
Recoverable Sodium	200.7	mg/L	250	9.0		
Recoverable Vanadium	200.7	mg/L		0.25		
Recoverable Zinc	200.7	mg/L	5.0	0.44		
Sodium	6010	mg/kg			104	148
Sulfate	300.0	mg/L	250	44.		
Total Mercury	245.1	mg/L	0.002	0.004		
Total Petroleum Hydrocarbons	EPA 418.1			1.3		
Total Solids	160.3	%			96.4	87.6
Vanadium	6010	mg/kg	1,000		37	37
Zinc	6010	mg/kg	10,500		46	41
alpha-BHC	EPA 608	ug/L	0.013	26.		
delta-BHC	EPA 608	ug/L		1.7		

Table 4.2.8.3

Analytical Results - Site IS-4

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	IS4-01 0687-MG-036 GW-88-0003 001318-0004	IS4-01 10'-11.5' 0687-SO-036 GS-88-0001 001099-0003	IS4-01 25'-26.5' 0687-SO-036 GS-88-0002 001099-0004
1,1,1-Trichloroethane	EPA 601	ug/L	200	5.8		
1,1-Dichloroethane	EPA 601	ug/L		2.2		
Aluminum	6010	mg/kg			14799	9901
Barium	6010	mg/kg			56	48
Beryllium	6010	mg/kg			0.3	0.2
Calcium	6010	mg/kg			6660	4070
Chromium	6010	mg/kg	50,000		27	57
Cobalt	6010	mg/kg			12	22
Copper	6010	mg/kg	1,850		29	24
Cyanide, Total	335.3	mg/L		0.01		
Di-n-butyl phthalate	Method 625	ug/L		13.		
Dissolved Barium	200.7	mg/L	1.0	0.16		
Dissolved Calcium	200.7	mg/L		141.		
Dissolved Magnesium	200.7	mg/L		19.		
Dissolved Manganese	200.7	mg/L	0.05	0.52		
Dissolved Sodium	200.7	mg/L	250	15.		
Dissolved Zinc	200.7	mg/L	5.0	0.04		
Iron	6010	mg/kg			296	21122
Magnesium	6010	mg/kg			10254	7261
Manganese	6010	mg/kg	11,000		729	572
Nickel	6010	mg/kg			30	25
Potassium	6010	mg/kg			825	
Recoverable Aluminum	200.7	mg/L		75.		
Recoverable Arsenic	206.2	mg/L	0.05	0.016		
Recoverable Barium	200.7	mg/L	1.0	2.3		
Recoverable Beryllium	200.7	mg/L	0.0000039	0.004		
Recoverable Calcium	200.7	mg/L		209.		
Recoverable Chromium	200.7	mg/L	0.05	0.05		
Recoverable Cobalt	200.7	mg/L		0.39		
Recoverable Copper	200.7	mg/L	1.0	1.2		
Recoverable Iron	200.7	mg/L	0.3	162.		
Recoverable Lead	239.2	mg/L	0.05	0.22		
Recoverable Magnesium	200.7	mg/L		62.		
Recoverable Manganese	200.7	mg/L	0.05	59.		
Recoverable Nickel	200.7	mg/L		1.5		
Recoverable Potassium	200.7	mg/L		5.		
Recoverable Sodium	200.7	mg/L	250	11.		
Recoverable Vanadium	200.7	mg/L		0.23		
Recoverable Zinc	200.7	mg/L	5.0	0.67		
Sodium	6010	mg/kg			190	231
Sulfate	300.0	mg/L	250	17.		
Total Mercury	245.1	mg/L	0.002	0.0002		
Total Mercury	245.1	mg/L	0.002	0.006		
Total Petroleum Hydrocarbons	3550/418.1 Mod.				529	53
Total Solids	160.3	%			94.6	90.9
Vanadium	6010	mg/kg	1,000		53	36
Zinc	6010	mg/kg	10,500		57	41
alpha-BHC	EPA 608	ug/L	0.013	2.3		

Table 4.2.8.3

Analytical Results - Site IS-5

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	IS5-01 0687-NG-037,GN-88-0003 001302-0002	IS5-01 5'-6.5' 0687-SO-037 GS-88-0001 001116-0005	IS5-01 50'-51.5' 0687-SO-037 GS-88-0002 001116-0006
Aluminum	6010	mg/kg			12850	10101
Barium	6010	mg/kg			65	30
Beryllium	6010	mg/kg			0.3	0.2
Calcium	6010	mg/kg			3938	3816
Chloride	300.0	mg/L	250	20.		
Chloroform	EPA 601	ug/L	100	0.78		
Chromium	6010	mg/kg	50,000		26	19
Cobalt	6010	mg/kg			10	9
Copper	6010	mg/kg	1,850		26	21
Cyanide, Total	335.3	mg/L		0.02		
Dissolved Barium	200.7	mg/L	1.0	0.11		
Dissolved Calcium	200.7	mg/L		58.		
Dissolved Magnesium	200.7	mg/L		6.9		
Dissolved Manganese	200.7	mg/L	0.05	0.016		
Dissolved Sodium	200.7	mg/L	250	14.		
Dissolved Zinc	200.7	mg/L	5.0	0.03		
Iron	6010	mg/kg			26425	19865
Magnesium	6010	mg/kg			8808	8530
Manganese	6010	mg/kg	11,000		601	393
Mercury	7471	mg/kg	100		0.09	
Nickel	6010	mg/kg	500		29	28
Nitrate as N	300.0	mg/L	10	2.5		
Potassium	6010	mg/kg			549	
Recoverable Aluminum	200.7	mg/L		70.		
Recoverable Arsenic	206.2	mg/L	0.05	0.010		
Recoverable Barium	200.7	mg/L	1.0	0.63		
Recoverable Beryllium	200.7	mg/L	0.0000039	0.003		
Recoverable Calcium	200.7	mg/L		92.		
Recoverable Chromium	200.7	mg/L	0.05	0.10		
Recoverable Cobalt	200.7	mg/L		0.25		
Recoverable Copper	200.7	mg/L	1.0	0.49		
Recoverable Iron	200.7	mg/L	0.3	150.		
Recoverable Lead	239.2	mg/L	0.05	0.085		
Recoverable Magnesium	200.7	mg/L		40.		
Recoverable Manganese	200.7	mg/L	0.05	14.		
Recoverable Nickel	200.7	mg/L		0.36		
Recoverable Sodium	200.7	mg/L	250	6.6		
Recoverable Vanadium	200.7	mg/L		0.21		
Recoverable Zinc	200.7	mg/L	5.0	0.43		
Sodium	6010	mg/kg			104	101
Sulfate	300.0	mg/L	250	23.		
Total Mercury	245.1	mg/L	0.002	0.0038		
Total Petroleum Hydrocarbons	EPA 418.1			0.6		
Total Solids	160.3	%			96.5	89.1
Vanadium	6010	mg/kg	1,000		45	36
Zinc	6010	mg/kg	10,500		54	42
bis(2-Ethylhexyl)phthalate	Method 8270	mg/kg			0.62	

Table 4.2.8.3

Analytical Results - Site IS-6

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	IS6-01 0687-HG-038,GN-88-0003 001302-0005	IS6-01 5'-6.5' 0687-SO-038 GS-88-0001 001043-0008	IS6-01 50'-51.5' 0687-SO-038-GS-88-0002 001075-0004	IS6-01 50'-51.5' DUPLICATE 0687-SO-038-GS-88-0002-DU 001075-0004
1,2,4,5-Tetrachlorobenzene	Method 8270	mg/kg	15		89		
2,6-Dichlorophenol	Method 8270	mg/kg			80		
2-Butanone	Method 8240	mg/kg	2,500			9.9	
2-Methylphenol	Method 8270	mg/kg			110		
2-Picoline	Method 8270	mg/kg			115		
Aluminum	6010	mg/kg			20424	12403	11886
Barium	6010	mg/kg			111	32	34
Benzo(a)anthracene	Method 8270	mg/kg			3.0		
Benzo(a)pyrene	Method 8270	mg/kg	0.061		3.6		
Benzo(k)fluoranthene	Method 8270	mg/kg			8.1		
Beryllium	6010	mg/kg			0.4		
Calcium	6010	mg/kg			2918	4910	5168
Chloride	300.0	mg/L	250	12.			
Chloroform	EPA 601	ug/L	100	0.32			
Chromium	6010	mg/kg	50,000		24	26	25
Chrysene	Method 8270	mg/kg			4.6		
Cobalt	6010	mg/kg			11	9	9
Copper	6010	mg/kg	1,850		19	22	22
Cyanide, Total	335.3	mg/L		0.01			
Dissolved Barium	200.7	mg/L	1.0	0.082			
Dissolved Calcium	200.7	mg/L		76.			
Dissolved Magnesium	200.7	mg/L		8.3			
Dissolved Manganese	200.7	mg/L	0.05	1.2			
Dissolved Sodium	200.7	mg/L	250	11.			
Dissolved Zinc	200.7	mg/L	5.0	0.02			
Fluoranthene	Method 8270	mg/kg			6.6		
Iron	6010	mg/kg			28249	24031	24160
Magnesium	6010	mg/kg			5305	9432	8915
Manganese	6010	mg/kg	11,000		676	517	568
Nickel	6010	mg/kg			24	26	23
Nitrate as K	300.0	mg/L	10	2.3			
Phenanthrene	Method 8270	mg/kg			4.8		
Pronamide	Method 8270	mg/kg			98		
Pyrene	Method 8270	mg/kg			6.0		
Recoverable Aluminum	200.7	mg/L		129.			
Recoverable Arsenic	206.2	mg/L	0.05	0.012			
Recoverable Barium	200.7	mg/L	1.0	1.3			
Recoverable Beryllium	200.7	mg/L	0.0000039	0.004			
Recoverable Calcium	200.7	mg/L		159.			
Recoverable Chromium	200.7	mg/L	0.05	0.19			
Recoverable Cobalt	200.7	mg/L		0.31			
Recoverable Copper	200.7	mg/L	1.0	0.93			
Recoverable Iron	200.7	mg/L	0.3	247.			
Recoverable Lead	239.2	mg/L	0.05	0.097			
Recoverable Magnesium	200.7	mg/L		80.			
Recoverable Manganese	200.7	mg/L	0.05	29.			
Recoverable Nickel	200.7	mg/L		0.75			
Recoverable Potassium	200.7	mg/L		7.			
Recoverable Sodium	200.7	mg/L	250	8.8			
Recoverable Vanadium	200.7	mg/L		0.36			
Recoverable Zinc	200.7	mg/L	5.0	0.77			
Sodium	6010	mg/kg				155	129
Sulfate	300.0	mg/L	250	19.			
Tetrachloroethene	EPA 601	ug/L	5	12.			
Total Mercury	245.1	mg/L	0.002	0.0048			
Total Petroleum Hydrocarbons	EPA 418.1			0.9		194	
Total Solids	160.3	%			75.4	77.4	
Trichloroethene	EPA 601	ug/L	5.0	8.1			
Vanadium	6010	mg/kg	1,000		60	43	47
Zinc	6010	mg/kg	10,500		48	50	47

Table 4.2.8.3

Analytical Results - Site IS-7

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	IS7-01 0687-NG-039,GN-88-0003 001302-0006	IS7-01 15'-16.5' 0687-SO-039 GS-88-0001 000883-0001	IS7-01 20'-21.5' 0687-SO-039 GS-88-0002 000883-0002
Aluminum	6010	mg/kg			10171	9935
Barium	6010	mg/kg			43	38
Beryllium	6010	mg/kg				0.1
Calcium	6010	mg/kg			3657	3671
Chloride	300.0	mg/L	250	10.		
Chromium	6010	mg/kg	50,000		19	19
Cobalt	6010	mg/kg			8	10
Copper	6010	mg/kg	1,850		21	12
Dissolved Barium	200.7	mg/L	1.0	0.019		
Dissolved Calcium	200.7	mg/L		65.		
Dissolved Magnesium	200.7	mg/L		18.		
Dissolved Manganese	200.7	mg/L	0.05	0.43		
Dissolved Sodium	200.7	mg/L	250	9.5		
Iron	6010	mg/kg			20686	20302
Magnesium	6010	mg/kg			6400	6263
Manganese	6010	mg/kg	11,000		434	616
Nickel	6010	mg/kg			21	22
Nitrate as N	300.0	mg/L	10	2.5		
Recoverable Aluminum	200.7	mg/L		5.5		
Recoverable Arsenic	206.2	mg/L	0.05	0.005		
Recoverable Barium	200.7	mg/L	1.0	0.14		
Recoverable Calcium	200.7	mg/L		68.		
Recoverable Cobalt	200.7	mg/L		0.01		
Recoverable Copper	200.7	mg/L	1.0	0.043		
Recoverable Iron	200.7	mg/L	0.3	13.		
Recoverable Lead	239.2	mg/L	0.05	0.011		
Recoverable Magnesium	200.7	mg/L		22.		
Recoverable Manganese	200.7	mg/L	0.05	2.2		
Recoverable Nickel	200.7	mg/L		0.03		
Recoverable Sodium	200.7	mg/L	250	8.4		
Recoverable Vanadium	200.7	mg/L		0.02		
Recoverable Zinc	200.7	mg/L	5.0	0.04		
Sodium	6010	mg/kg			80	98
Sulfate	300.0	mg/L	250	25.		
Total Mercury	245.1	mg/L	0.002	0.0002		
Total Petroleum Hydrocarbons	EPA 418.1			2.0		
Total Solids	160.3	%			87.5	92.6
Trichloroethene	EPA 601	ug/L	5.0	76.		
Vanadium	6010	mg/kg	1,000		34	32
Zinc	6010	mg/kg	10,500		39	37

Table 4.2.8.3

Analytical Results - Site IS-8

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	IS8-01 0687-NG-040,GN-88-0003 001302-0001	IS8-01 DUPLICATE 0687-NG-040,GN-88-0003D 001302-0001	IS8-01 20'-21.5' 0687-SO-040 GS-88-0001 000871-0001	IS8-01 25'-26.5' 0687-SO-040 GS-88-0002 000871-0002
1,1,1-Trichloroethane	EPA 601	ug/L	200	0.90	0.93		
1,1-Dichloroethane	EPA 601	ug/L		2.1	2.0		
4-Methyl-2-pentanone	EPA 602	ug/L		14.	14.		
Aluminum	6010	mg/kg				12592	12218
Barium	6010	mg/kg				34	37
Beryllium	6010	mg/kg				0.2	0.1
Calcium	6010	mg/kg				4722	4626
Chloride	300.0	mg/L	250	14.	13.		
Chromium	6010	mg/kg	50,000			22	20
Cobalt	6010	mg/kg				9	9
Copper	6010	mg/kg	1,850			19	24
Dissolved Arsenic	206.2	mg/L	0.05		0.004		
Dissolved Barium	200.7	mg/L	1.0	0.037	0.037		
Dissolved Calcium	200.7	mg/L		99.	100.		
Dissolved Iron	200.7	mg/L	0.3	1.4	1.0		
Dissolved Magnesium	200.7	mg/L		16.	16.		
Dissolved Manganese	200.7	mg/L	0.05	1.6	1.9		
Dissolved Sodium	200.7	mg/L	250	7.3	7.8		
Iron	6010	mg/kg				25918	23606
Magnesium	6010	mg/kg				9129	8541
Manganese	6010	mg/kg	11,000			504	403
Nickel	6010	mg/kg				27	24
Recoverable Aluminum	200.7	mg/L		1.9	2.0		
Recoverable Arsenic	206.2	mg/L	0.05	0.008	0.004		
Recoverable Barium	200.7	mg/L	1.0	0.053	0.055		
Recoverable Calcium	200.7	mg/L		100.	99.		
Recoverable Copper	200.7	mg/L	1.0	0.023	0.026		
Recoverable Iron	200.7	mg/L	0.3	5.7	6.2		
Recoverable Lead	239.2	mg/L	0.05	0.010	0.008		
Recoverable Magnesium	200.7	mg/L		16.	16.		
Recoverable Manganese	200.7	mg/L	0.05	1.9	1.6		
Recoverable Nickel	200.7	mg/L		0.01	0.01		
Recoverable Sodium	200.7	mg/L	250	6.0	6.1		
Recoverable Vanadium	200.7	mg/L			0.01		
Recoverable Zinc	200.7	mg/L	5.0	0.02	0.02		
Sodium	6010	mg/kg				73	119
Sulfate	300.0	mg/L	250	19.	19.		
Toluene	EPA 602	ug/L	2000	11.	11.		
Total Dissolved Solids	160.1	mg/L	500		400.		
Total Mercury	245.1	mg/L	0.002	0.0002	0.0001		
Total Petroleum Hydrocarbons	EPA 418.1			2.0			
Total Solids	160.3	%				95.3	84.3
Trichloroethene	EPA 601	ug/L	5.0	6.6	6.8		
Vanadium	6010	mg/kg	1,000			46	42
Zinc	6010	mg/kg	10,500			49	50

4.2.8.1.5 Discussion of Analytical Data

Contamination by petroleum hydrocarbon compounds was prevalent at Sites IS-1 through IS-8. However, concentrations and type of contaminants varied from site to site. The concentration levels for organic compounds recorded are discussed for each individual site. Figures 4.2.8.10 through 4.2.8.22 show organic compounds detected at Sites IS-1 through IS-4. Organic compounds occurring at Sites IS-5 and IS-6 are shown in Figures 4.2.8.23 through 4.2.8.40 and Figures 4.2.8.41 through 4.2.8.46 show the compounds detected at Sites IS-7 and IS-8.

Site IS-1: Well W-18 at Site IS-1 contained BETX (benzene, ethylbenzene, toluene, and xylene) at a concentration of 1795 ug/L (Figures 4.2.8.10 through 4.2.8.13). This was the only sampling point where all components of the BETX fraction were encountered. The water sample from this well also contained naphthalene (280 ug/L), bis(2-ethyhexyl)phthalate (720 ug/L), 2-methylnaphthalene (500 ug/L), and total petroleum hydrocarbon (78 mg/L). Water from well W-19 at Site IS-1 was contaminated with 1,1,1-trichloroethane (3.1 ug/L) and 1,1-dichloroethane (7.1 ug/L). Well IS1-01 contained 1,1-dichloroethane at a concentration of 1.1 ug/L. Soil in IS1-01 had petroleum hydrocarbon concentration of 910 and 210 mg/kg at depths of 5 and 31 feet, respectively. No other contaminants were detected in the soil or water sampled from this site.

Site IS-2: A water sample from this well contained total petroleum hydrocarbons at a concentration of 0.7 mg/L.

Site IS-3: Site IS-3 was found to be contaminated with the organochlorine pesticides alpha BHC (26 ug/L) and delta-BHC (1.7 ug/L). No other organic contaminants were detected in soil or water samples from the site.

Site IS-4: The chlorinated hydrocarbon compounds 1,1,1-trichloroethane (5.8 ug/L) and 1,1-dichloroethane (2.2 ug/L) were detected in a water sample from well IS4-01. Alpha-BHC (2.3 ug/L) and di-n-butylphthalate (13 ug/L), were also detected in this water sample. Total petroleum hydrocarbons were detected in soil samples from well IS4-01 at concentrations of 530 mg/kg at 10 feet and 53 mg/kg at 25 feet.

Site IS-5: A soil sample collected from the 5-foot depth of boring IS5-01 contained bis(2-ethyhexyl) phthalate (0.62 mg/kg). Water samples from the completed well at the site contained petroleum hydrocarbons (0.6 mg/L) and chloroform (0.78 ug/L).

Site IS-6: A soil sample from the 5-foot depth of borehole IS6-01 contained 2-methylphenol (110 mg/kg), pronamide (98 mg/kg), 2,6-dichlorophenol (80 mg/kg), 1,2,4,5-tetrachloro-benzene (89 mg/kg), and 2-picoline (120 mg/kg). This soil sample also contained the following polycyclic aromatic hydrocarbon (PAH) compounds: benzo(a)anthracene (3.1 mg/kg), benzo(a)pyrene (3.6 mg/kg), benzo(k)fluoranthene (8.1 mg/kg), chrysene (4.6 mg/kg), fluoranthene (6.6 mg/kg), phenanthrene (4.8 mg/kg), and pyrene (6.0 mg/kg). The soil sample from 50 feet also contained petroleum hydrocarbon (190 mg/kg) and 2-butanone (9.9 mg/kg). Water samples from the well installed at Site IS-6 were contaminated with tetrachloroethene (12 ug/L), trichloroethene (8.1 ug/L), and chloroform (0.32 ug/L). Total petroleum hydrocarbon concentration of the water sample was 0.9 mg/L.

Site IS-7 and IS-8: Water samples from wells IS7-01 and IS8-01 both contained total petroleum hydrocarbon concentrations of 2.0 mg/L. These water samples also contained trichloroethene (76 and 6.6 ug/L, respectively). In addition, the water sample from well IS8-01

contained toluene (11 ug/L), 4-methyl-2-pentanone (14 ug/L) 1,1-dichloroethane (2.1 ug/L), and 1,1,1-trichloroethane (0.9 ug/L).

Metals analyses were also completed on both the soil and water samples collected at Sites IS-1 through IS-8. A complete summary of the metals data is presented in Table 4.2.8.3. A summary of the ranges of metals detected in soil and water is presented in Table 4.2.8.4.

Table 4.2.8.4 Summary of Ranges for Total Metals Detected at Sites IS-1 through IS-8.

	Soil (mg/kg)	Water (dissolved; mg/L)	Water (total;mg/L)
Al	9800 - 20400	ND	1.9 - 129
Fe	300 - 28,300	1.4 - 3.3	4.6 - 247
Mn	390 - 730	0.009 - 6.7	1.9 - 59
Mg	5300 - 10,300	6.9 - 20	15 - 80
Ca	2900 - 6700	58 - 169	68 - 272
Na	73 - 400	4.4 - 20	4.8 - 15
K	540 - 820	ND	5.0 - 7.0
Cl	-	-	10 - 20
Ba	less than 110	less than 0.17	less than 2.3
Cr	less than 57	less than ND	less than 0.19
Co	less than 22	less than 0.01	less than 0.39
Cu	less than 29	less than ND	less than 1.2
Ni	less than 31	less than 0.01	less than 0.75
V	less than 60	less than ND	less than 0.36
Zn	less than 57	less than 0.06	less than 0.77
Hg	0.09	ND	0.0002 - 0.007
As	NA	0.010	0.005 - 0.019
Pb	ND	ND	0.0002 - 0.22

ND - Not Detected
NA - Not Analyzed

Water samples also contained these metals with total recoverable concentrations as high as 129, 247, 59 and 80 mg/L, respectively. Dissolved concentrations ranged from nondetectable for aluminum, mercury, and lead to 20 mg/L for magnesium. These concentrations are related to the natural distribution of minerals in the soils of the area. High calcium, sodium and potassium levels detected in the soils and water are also be due to the natural mineral content of the surrounding soils, and are similar to concentrations at the background wells.

Sulfate and chloride ions were detected in water samples from all wells at concentrations ranging from 9.2 to 44 mg/L and 10 to 20 mg/L, respectively.

Relatively low concentrations of other elements such as barium, chromium, cobalt, copper, nickel, vanadium, and zinc were detected at concentrations greater than 8 mg/kg and less than 110 mg/kg in soil samples from all borings. Most water samples from wells at Sites IS-1 through IS-6 contained all of the elements listed above in the total recoverable form at concentrations less than 2.3 mg/L. Another sample from Site IS-7 had all of the same elements except chromium. Concentration levels of the elements present were less than 0.15 mg/L. Water samples from wells W-18 and W-19 at Site IS-1 contained all of the elements listed above except chromium, cobalt and vanadium at concentrations less than 0.05 mg/L.

Trace amounts of beryllium (0.4 mg/kg or less) were detected in soil samples from the wells at Sites IS-2 through IS-8. Trace amounts (less than 0.1 mg/L) of arsenic, beryllium, cyanide, lead, and mercury were detected in the water at Sites IS-1, IS-3, IS-4, and IS-5, and IS-6. Water samples from Sites IS-2 contained all of the above metals except beryllium. Of these 5 metals (arsenic, beryllium, cyanide, lead and mercury), only arsenic, lead and mercury were detected in water from Sites IS-7 and IS-8, arsenic and lead from well W-18, and only lead was detected in the water sample from well W-19.

4.2.8.2 Sampling or Analytical Problems

Sampling or analytical problems including loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan are addressed below for Sites IS-1 through IS-8.

4.2.8.2.1 Loss of Samples

All soil and water samples collected for laboratory analysis from Sites IS-1 through IS-8 were received by the laboratory.

4.2.8.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is possible that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. Bis(2-ethylhexyl) phthalate, a common laboratory reagent, was detected at a concentration of 720 ug/L in the water sample from well W-18 and of 0.6 ug/L in a soil sample from Site IS-5. The QA/QC data does not indicate that bis(2-ethylhexyl) phthalate was a laboratory or field contaminant.

4.2.8.2.3 Analytical Results Obtained Under Out-of-Control Conditions

A water sample and 2 soil samples were collected from the test boring at each of the 8 IS sites. Additional water samples were collected from previously installed wells W-18 and W-19 located at Site IS-1. No out-of-control conditions occurred during drilling or water sampling operations at any of the sites.

4.2.8.3 Significance of Findings for Sites IS-1 Through IS-8

Analytical methods detected petroleum hydrocarbons, other volatile organic compounds and metals in water and soil samples from Sites IS-1 through IS-8.

Site IS-1: Benzene was detected in water from well W-18 at Site IS-1 at a concentration of 35 ug/L which exceeds State of Alaska Primary Drinking Water Standards of 5 ug/L. The primary standards for cadmium was also exceeded based on dissolved concentrations. Water from this well and IS1-01 exceeded State of Alaska Secondary Drinking Water Standards of 0.05 mg/L for manganese and 0.3 mg/L for iron. Water from well W-19 and IS1-01 exceeded secondary standards for manganese. A water sample collected in 1986 from this well exceeded State of Alaska standards of 0.033 ug/L for 1,1-dichloroethene. This compound was not detected in 1988 samples. The 1986 sample from W-19 exceeded State of Alaska standards for 1,1-dichloroethene. Pure product was collected during sampling of the well. Since the water sample from well W-18 exhibited a petroleum odor and sheen, State of Alaska Drinking Water Standards for petroleum hydrocarbons were exceeded.

During the drilling of well IS1-01 no petroleum odors or stains were observed, but an HNu meter detected organic vapors. The presence of petroleum hydrocarbons in the soil was confirmed at well IS1-01 by the laboratory analysis, i.e. 907 and 212 mg/kg at 5 and 31 feet, respectively. These levels exceed the proposed soil cleanup level guidelines discussed in 4.1.1. The source of petroleum hydrocarbons and volatile organics in the soil and groundwater at this site is probably from the numerous reported fuel spills, the largest of which was 1300 gallons.

Site IS-2: Total petroleum hydrocarbons were detected in a water sample from well IS2-01. However, since the water sample from this well did not exhibit a petroleum odor and sheen, State of Alaska Drinking Water Standards for petroleum hydrocarbons were not exceeded.

During the drilling of well IS2-01, no odors or stains were observed, but an HNu meter detected organic vapors.

The probable source of petroleum hydrocarbons in the groundwater at this site is an active leak of diesel fuel which was observed east of the well. Fuel was observed dripping from a fuel tank vent and the ground surrounding the leak was stained. Rinse waters from the aircraft maintenance hangar may have contributed to the contamination.

Site IS-3: The pesticide alpha-BHC was detected in water from well IS3-01 at a concentration exceeding EPA National Ambient Water Quality Criteria (NAWQC) Standard of 0.013 ug/L. Water from this well exceeded Secondary Drinking Water Standards of 0.05 mg/L for manganese. Since the water sample from well IS3-01 did not have a petroleum odor or sheen, State of Alaska Drinking Water Standards for petroleum hydrocarbons were not exceeded.

During the drilling of well IS3-01 no petroleum odors or stains were observed, but an HNu meter detected organic vapors.

The source of petroleum hydrocarbons in the groundwater at this site is fuel spills or solvents used for aircraft cleaning. The source of the pesticides is unknown.

Site IS-4: The pesticide alpha-BHC was detected in water from well IS4-01 at a concentration exceeding EPA NAWQC Standard of 0.013 ug/L. Water from this well also exceeded Secondary Drinking Water Standards of 0.05 mg/L for manganese. Since the water sample from well IS4-01 did not have a petroleum odor or sheen, State of Alaska Drinking Water Standards for petroleum hydrocarbons were not exceeded.

During the drilling of well IS4-01 no odors or stains were observed, but an HNu meter detected organic vapors. The presence of petroleum

hydrocarbons in the soil were confirmed at well IS4-01 through laboratory analysis, i.e. 530 mg/kg and 53 mg/kg at 10 and 25 feet, respectively. The shallow soil sample exceeds the proposed soil cleanup guidelines discussed in 4.1.1.

The source of petroleum hydrocarbons and volatile organics in the soil and groundwater at this site is solvents used in aircraft painting and maintenance. The source of pesticides is unknown.

Site IS-5: Chloroform was detected in water from well IS5-01 but the amount detected was under the regulatory limit of 100 ug/L for total trihalomethanes. The sample did not have a petroleum odor or sheen; therefore, State of Alaska Drinking Water Standards for petroleum hydrocarbons were not exceeded.

During the drilling of well IS5-01 no odors or stains were observed, and an HNu meter did not detect organic vapors.

The source of volatile organics in the soil and groundwater at this site is fuel spilled during refueling operations, and solvents used for aircraft cleaning. The source of pesticides is unknown.

Site IS-6: Trichloroethene and tetrachloroethene were detected in water from well IS6-01 at concentrations exceeding their MCLs of 5.0 ug/L. Water from this well also exceeded Secondary Drinking Water Standards of 0.05 mg/L for manganese. Since the water sample from well IS6-01 did not have a petroleum odor or sheen, State of Alaska Drinking Water Standards for petroleum hydrocarbons were not exceeded.

A surface soil sample from well IS6-01 contained numerous PAH compounds, in addition to several chlorinated hydrocarbons and TPH (190 mg/kg). The proposed soil cleanup guidelines are discussed in

4.1.1. During the drilling of well IS6-01 no odors or stains were observed, but an HNu meter detected organic vapors.

The source of petroleum hydrocarbons and volatile organics in the soil and groundwater at this site is numerous small fuel and solvent spills.

Site IS-7: Trichloroethene was detected in water from well IS7-01 at a concentration exceeding the MCL of 5.0 ug/L. Water from this well also exceeded State of Alaska Secondary Drinking Water Standards of 0.05 mg/L for manganese. Since the water sample from well IS7-01 did not have a petroleum odor or sheen, State of Alaska Drinking Water Standards for petroleum hydrocarbons were not exceeded.

During the drilling of well IS7-01 petroleum odor was detected at the 25-foot depth, and an HNu meter detected organic vapors.

The source of petroleum hydrocarbons and volatile organics in the groundwater at this site is fuel and solvents spilled into floor drains which empty into a seepage pit north of building 21-900.

Site IS-8: Trichloroethene was detected in water from well IS8-01 at a concentration exceeding the MCL of 5.0 ug/L. Water from this well also exceeded State of Alaska Secondary Drinking Water Standards of 0.05 mg/L for manganese and 0.3 mg/L for iron. Since the water sample from well IS8-01 had a petroleum odor and sheen, State of Alaska Drinking Water Standards for petroleum hydrocarbons were exceeded.

During the drilling of well IS8-01 no petroleum odors or stains were observed, and an HNu meter did not detect organic vapors.

The source of petroleum hydrocarbons and volatile organics in the groundwater at this site is solvents spilled into floor drains in the nearby hangar.

Pathways of exposure at Sites IS-1 through IS-8 include contact with and ingestion or uptake of contaminated ground or surface water and contact with or ingestion of contaminated surface soils. Receptors of the contamination are humans, wildlife, and plants.

4.2.8.3.1 Zones of Contamination

The data density at each site is minimal, therefore, it is difficult to determine general zones of contamination. Soil gas surveys were not conducted in the areas of Sites IS-1 through IS-8. Site IS-1 was the only IS site where samples were collected from more than 1 well. At this site, the most downgradient well, well W-18, was found to have the highest levels of contamination and contained pure product.

Minimal generalizations within sites can be made, however, some comparisons of the data among sites can be made. For example, well IS2-01 is located upgradient from Sites IS-1 and IS-4. This well was found to be contaminated only with petroleum hydrocarbons. Wells IS3-01 and IS4-01 are downgradient of well IS3-01. All 3 of these wells were contaminated with several of the same organic compounds. No other upgradient/downgradient relationships are apparent between the remaining IS sites (IS-5 through IS-8).

4.2.8.3.2 Contaminant Migration

Volatile organics may be migrating in the groundwater at Sites IS-1 through IS-4. Groundwater flow at these sites is in a southwest

direction, and contamination by total petroleum hydrocarbons and several organic compounds seen upgradient in Site IS-3 extend downgradient through Site IS-1 to Site IS-4. However, each of these sites has its own source of contamination, which may be the sole source of organic contaminants at each site.

Wells at the remaining sites do not have corresponding downgradient sampling locations, therefore contamination migration paths cannot be determined.

4.2.8.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off Base migration of contamination at Sites IS-1 through IS-4 is unknown (Section 4.2.8.3.2). The boundaries of contamination at each site have not been clearly defined; however, they are expected to be quite small, encompassing areas of floor drain output.

Sites IS-1 through IS-4: Groundwater flow at Sites IS-1 through IS-4 is to the southwest, with the nearest base boundary over 1 mile southwest of Site IS-4. However, these hangar sites are less than 3500 feet upgradient from the east-west runway. Storm drains at the runway extend to Cherry Hill Ditch. Should contamination from Site IS-1 through IS-4 reach the storm drains at the runway and Cherry Hill Ditch, it could be carried off base.

Sites I-5 and IS-6: Groundwater flow in the vicinity of Sites IS-5 and IS-6 is to the west. The nearest base boundary in that direction is over a mile away.

Sites IS-7 and IS-8: The direction of groundwater flow at these sites is to the south. The nearest base boundary to the south is about 3000 feet distant. Ship Creek is about 4000 feet to the south of these

sites. Should contamination reach the creek, it would be carried further off the Base.

4.2.8.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the sites infers the following conclusions:

Sites IS-1 through IS-4: The direction of groundwater flow is to the southwest with a gradient of about 5 feet per mile.

Sites IS-5 and IS-6: The direction of groundwater flow is west-northwest with a gradient of approximately 10 feet per mile.

Sites IS-7 and IS-8: Groundwater flow direction is to the south, and the gradient is about 45 feet per mile.

The rate of migration of the contaminants in the groundwater at each site will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of the migration rate of the dissolved chemicals.

4.2.8.3.2.3 Time of Travel to Receptors

The primary receptors at present are humans, wildlife, and plants. Primary pathways are ingestion of contaminated ground and surface water, or the handling of contaminated surface soils. A secondary exposure route would be the ingestion of contaminated plants. The

following time of travel to these receptors can be estimated for each site:

Sites IS-1 through IS-4: Cherry Hill Ditch is located about 5000 feet southwest of the most downgradient site, IS-4. Hydraulic conductivity values have not been determined for this site; thus, time of travel to the ditch cannot be estimated. Runway drains empty into the ditch. Any contamination entering the drains from the nearby sites would reach the ditch in a shorter amount of time. Cherry Hill Ditch was sampled as a part of this study (Section 4.2.19).

Sites IS-5 and IS-6: There are no downgradient drinking water wells or surface water bodies within a mile of these sites. However, surface soils at Site IS-6 are contaminated with several PAH and chlorinated organic compounds. Time of travel to receptors is immediate since surface soils are contaminated. The site is located in a developed area of the base and is easily accessible. In addition, any surface runoff or accumulated precipitation may become contaminated by the soils. The surface runoff may flow downhill to a nearby taxiway. Time of travel is negligible.

Sites IS-7 and IS-8: Ship Creek is approximately 4000 feet downgradient of Sites IS-7 and IS-8. Hydraulic conductivity have not been determined for this site; thus, time of travel to the creek cannot be estimated. A point on the creek downgradient of the wells was sampled as part of this study (Section 4.2.2.3).

4.2.8.3.2.4 Applicability of Solute Transport Models

Solute transport models may be important at Sites IS-1 through IS-8. Wells installed to the south and southwest of the wells presently

located at Site IS-1 through IS-4 and IS-7 and IS-8 may provide additional hydrogeological data and allow the formation of more accurate solute transport models. Wells located both to the west (downgradient) and to the east (upgradient) of Sites IS-5 and IS-6 would provide additional information. The results of this modeling would help to determine the potential risk for downgradient water supplies and surface water.

4.2.8.3.2.5 Expected Spatial and Temporal Variations in Concentration

Contamination by petroleum hydrocarbons was detected in several soil samples collected at Sites IS-1 through IS-8. The spacial extent of contamination in groundwater has been described for each group of sites in Sections 4.1.8.2 and 4.1.8.3.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or additional precipitation. Solubility of the contaminants is also affected by changes in water pH and temperature that occur on a seasonal basis.

4.2.8.3.3 Baseline Risk Assessment

Contamination in relation to exposure routes, receptors and health effects are evaluated in the following sections.

4.2.8.3.3.1 Waste Characterization

The primary wastes at the sites are petroleum hydrocarbons and volatile organics. Total petroleum hydrocarbons were detected in soil and/or groundwater samples at Sites IS-1 through IS-3 and IS-5 through IS-8. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects. Benzene was detected in water from 1 well at IS-1. This compound was detected at a level 7 times

the State of Alaska standard of 5 ug/l. This volatile organic is a known human carcinogen. Other suspected carcinogenic substances detected in water samples from at the sites are:

Trichloroethene	- Sites IS-6, IS-7 and IS-8
Tetrachloroethene	- Site IS-6
Chloroform	- Sites IS-5 and IS-6
Alpha-BHC	- Sites IS-3 and IS-4
Delta-BHC	- Site IS-3

Toluene and ethylbenzene were detected in a water sample from Site IS-1. These volatile organics are less toxic than benzene and were detected below regulatory limits of 14300 and 1400 ug/L, respectively (EPA NAWQC standards). Organic compounds of low toxicity such as xylenes and naphthalenes were also detected at this site. There are no state or federal standards for these compounds. The compound 1,1,1-trichloroethane was detected in water from IS-1, IS-4 and IS-8 at levels below its MCL of 200 ug/L. This solvent is used in cold metal cleaning and can be narcotic at high concentrations.
Dissolved manganese was detected above expected background levels and exceeding State of Alaska Secondary Drinking Water Standards in water samples from Sites IS-1, IS-3, IS-4 and IS-6 through IS-8. The dissolved manganese may be from introduced waste, or it may be from natural sources of the metal in soil (personal communication, S. Ede, Chemical and Geological Laboratories, 1989). Manganese is used in steel and metal alloys and can affect the central nervous system. However, toxicity of this metal is expected to occur only at concentrations much higher than its secondary maximum contaminant level of 0.05 mg/L (18 AAC 80.060).

4.2.8.3.3.2 Source and Release Characterization

Petroleum hydrocarbons and volatile organics were released to the environment as the result of spills and leaks to floor drains at each

site. Section 4.2.8.3 provides the details of type and amount spilled or leaked at the individual sites. There have been no recorded efforts to clean up materials spilled or deposited into the floor drains.

4.2.8.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons and volatile organics released to the environment at the IS sites includes long-term natural degradation, dispersion of the contaminants through surface runoff, or uptake by living organisms. Another possible fate is the volatilization of fractions that have vapor pressures greater than 1 mm Hg. The fate of metals in the environment includes oxidation, chelation and/or uptake by living organisms.

Dissolved contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration with the groundwater through the process of advection. Non-soluble compounds migrate along the groundwater table gradient. Additional transport can occur in the form of surface run-off or release of vapor to the atmosphere. Finally contaminated soil or water from the site can be transported through human intervention.

4.2.8.3.3.4 Exposure Pathways

At present, an exposure pathway for humans, fish and wildlife is contact with or ingestion of contaminated ground or surface water, or plants. An additional pathway is through contact with contaminated surface soils.

4.2.8.3.3.5 Identification of Receptors

Receptors are humans, wildlife, fish and plants. Human receptors include anyone ingesting or coming in contact with groundwater, with

water from Cherry Hill Ditch and Ship Creek, or handling surface soil at Site IS-6. Plants are possible but unlikely receptors at Sites IS-1 through IS-8 due to the lack of large trees and developed nature of the sites, and the depth of groundwater (over 20 feet). However, humans may be exposed to contamination by the ingestion of plants or berries that have taken up ditch or creek water. Fish are abundant in Ship Creek, but were not observed in Cherry Hill Ditch. Based on available data, the potential for expsoure by completion of contaminant pathways (Section 4.1.8.3.3.4) is unknown. Prior to determining this potential for exposure, the release mechanism of contaminants at the IS sites must be known.

4.2.8.3.3.6 Threat to Human Health

A possible threat to human health is the drinking of or contact with water from Cherry Hill Ditch. Samples from the ditch were analyzed as part of this study (Section 4.1.19). It is unlikely that anyone would drink the water due to the presence of petroleum odor. In addition, the contaminant concentrations were within drinking water limits. The overall threat from ditch water is assessed as low (Section 4.1.19).

Another possible threat to human health is the drinking of Ship Creek water or the ingestion of fish from Ship Creek. As part of this study, water and sediments were collected and analyzed from a point on Ship Creek, south and downgradient from Site IS-8 (Section 4.2.23). The samples did not contain petroleum hydrocarbons or volatile organic compounds above method detection limits. The threat to human health from exposure to Ship Creek water is minimal to non-existant.

4.2.8.3.3.7 Carcinogenic Risks

Several carcinogenic compounds were detected at Sites IS-1 through IS-8. These compounds are: benzene, trichloroethene, tetrachloro-

ethene, chloroform, alpha-BHC and delta-BHC. State and federal drinking water regulations for these chemicals are presented in Section 4.2.8.3. The EPA Weight-of-Evidence categories for these chemicals are presented in Table 4.1.8.

4.2.8.3.3.8 Threat to Wildlife

Threat to wildlife is possible through ingestion of contaminated surface waters. Cherry Hill Ditch constitutes the nearest surface water body. However, the threat is minimal since ditch waters were within State of Alaska standards (Section 4.2.19).

4.2.8.3.3.9 No Threat to Health

Sites IS-2 and IS-5: Water samples from these sites were in compliance with all federal and state drinking water regulations. Receptors are present, but the duration and frequency of exposure is not expected to cause adverse effects.

4.2.8.4 Prioritization of Sites for Remedial Alternatives

4.2.8.4.1 Site IS-1

Groundwater samples collected from this site in 1988 were contaminated above State of Alaska standards for benzene, a known human carcinogen. In addition, pure product was collected during sampling of well W-18. Offsite migration may be occurring since the most downgradient well is the most highly contaminated. Receptors and exposure pathways are present.

This site is assigned a high priority and will probably require remedial action due to the exceeding of State of Alaska standards and the presence of pure product on the water table. Installation and

sampling of 3 additional downgradient monitoring wells is recommended at this site to aid in delineating plume dimensions. One of the new wells should be located near W-18. This well should be screened in the deeper region of the unconfined aquifer. The 2 other wells should be located downgradient of the existing wells. One of these new wells should be a dual completion well, screened in both the upper and lower regions of the aquifer. Data from the deeper region of the aquifer will be used to delineate the vertical extent of contamination. Seasonal sampling shall be performed at the monitoring wells. Groundwater samples from the proposed and existing wells should be tested for TPH, VOCs, PAHs, and metals including lead, chromium, and mercury.

4.1.8.4.2 Sites IS-3, IS-4, IS-6, IS-7 and IS-8

Sites IS-3 and IS-4: Groundwater samples from these sites were contaminated above compliance levels for the pesticides alpha-BHC. Receptors and exposure pathways are present, but contaminant release and migration characteristics have not been shown since only one well was installed and sampled at each site. Health effects cannot be ruled out.

Sites IS-6, IS-7 and IS-8: Groundwater samples from these sites exceeded state primary contaminant levels for trichloroethene, a suspected carcinogen. At well IS6-01, groundwater sample exceeded NAWQC standard for tetrachloroethene. In addition, water from well IS8-01 at Site IS-8 exhibited a petroleum odor and sheen, thereby exceeding State of Alaska standards for total petroleum hydrocarbons. Receptors and exposure pathways are present. Contaminant release and migration characteristics are unknown since only 1 well was sampled at each site. Threat to health cannot be ruled out at any of these 3 sites.

The potential of offsite migration of contamination is unknown. These sites are assigned a medium priority for remedial alternatives due to

the exceeding of water quality regulations. Further work at each site should include the following.

Site IS-3: 3 additional wells should be added, 1 upgradient and 2 downgradient. All wells should be sampled for TPH, volatile organic compounds, organochlorine pesticides and PCBs, and metals. Soil samples collected during well installation should be analyzed for the same constituents.

Site IS-4: 1 new well should be located downgradient of the site. Water and soil samples from the new and existing wells should be analyzed for the same parameters listed for Site IS-3. Data collected from 2 new wells downgradient of Site IS-1 can be considered as upgradient data for this site.

Site IS-6: 3 new wells should be installed, 1 upgradient just west of Hangar 15, and 2 downgradient of the site. Soil samples collected during well installation will be analyzed for TPH, volatile and semi-volatile organic compounds, and metals. Groundwater samples collected from the new and existing wells will be analyzed for TPH, volatile organic compounds, polycyclic aromatic compounds, and metals.

Site IS-7: 4 new wells are needed at this site. One well will be located next to existing well IS07-10 and will be screened in the lower region of the unconfined aquifer to determine the vertical extent of contamination. One new well will be located upgradient of the site, and 2 will be located downgradient, near Juniper Drive. The eastern-most downgradient well will be a dual-completion well, screened in the upper and lower regions of the unconfined aquifer. Soil samples collected during well installation will be analyzed for TPH and volatile organic compounds. Groundwater samples collected from the new and existing wells will also be analyzed for TPH and volatile organic compounds.

Site IS-8: 4 new wells are also required at this site. They should be installed and sampled just as the new wells at Site IS-7. One well should be upgradient, 1 near the existing well (screened in the deep region of the aquifer), and 2 downgradient (one of which will be a dual-completion well).

4.1.8.4.3 Sites IS-2 and IS-5

Water samples collected from well IS2-01 contained petroleum hydrocarbons, but was not out-of-compliance with State of Alaska water quality regulations. The sample from well IS5-01 contained chloroform and total petroleum hydrocarbons but was also in compliance for all State of Alaska standards. No further action is recommended for sites IS-2 and IS-5.

4.2.9 Discussion of Results for Site S-6, PCB Transformer Storage Area

A large number of transformers were stored on the ground at Site S-6 during the 1970's (Figure 4.2.9.1). Although no significant transformer oil spills have been documented, some leakage may have occurred at this site.

4.2.9.1 Presentation of Results at Site S-6

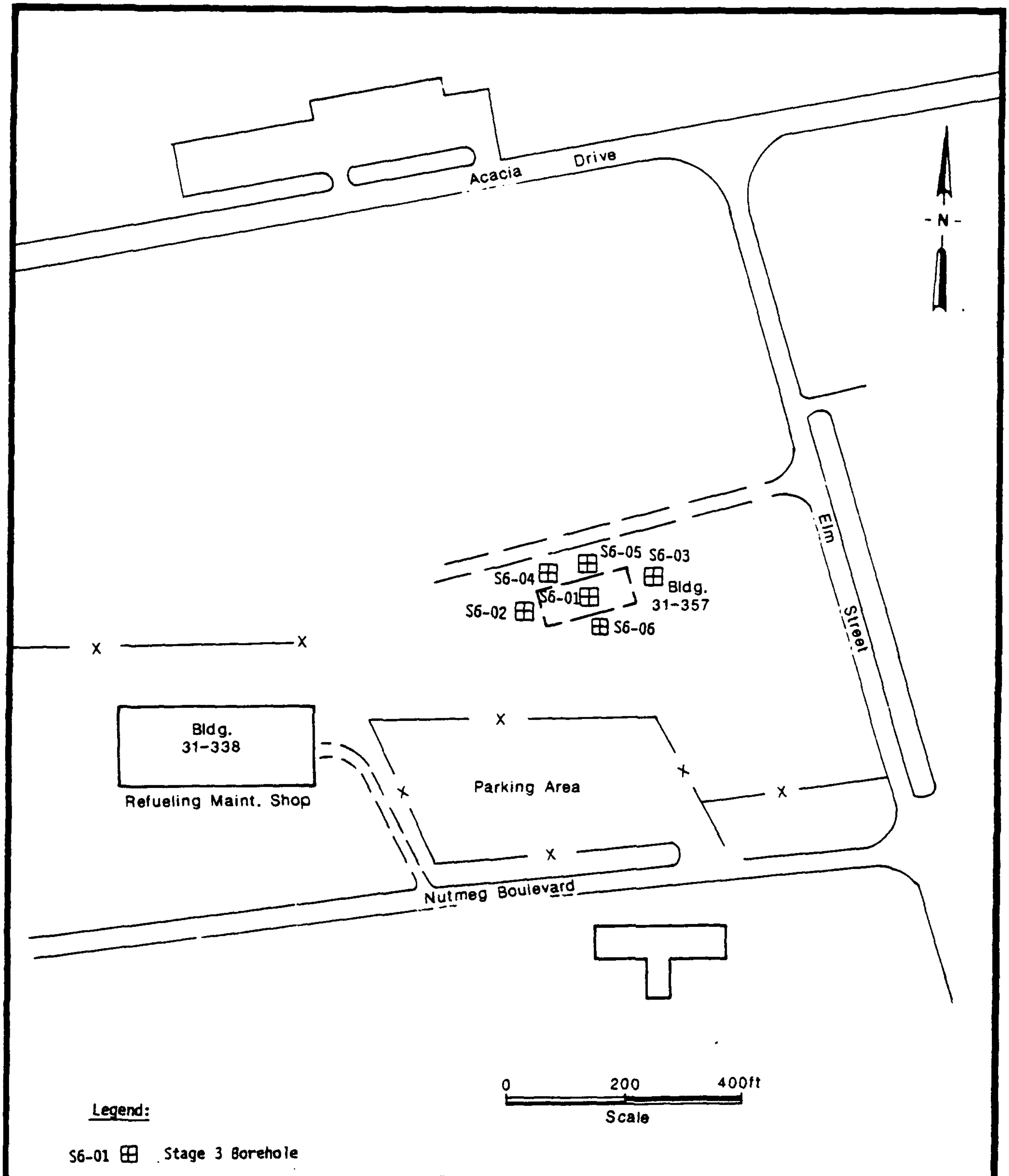
Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on site maps.

4.2.9.1.1 Site Geology

The S-6 site is located at an elevation of 145 feet on flat terrain and is underlain by late-Quaternary glacial outwash deposits consisting chiefly of coarse sands and gravels with some silt. A schematic geologic cross section is presented in Figure 4.2.9.2. Although subsurface explorations at the site did not exceed a depth of 5 feet, the surficial outwash sediments are assumed to overlie clayey units of the Bootlegger Cove Formation at a depth of about 50 feet.

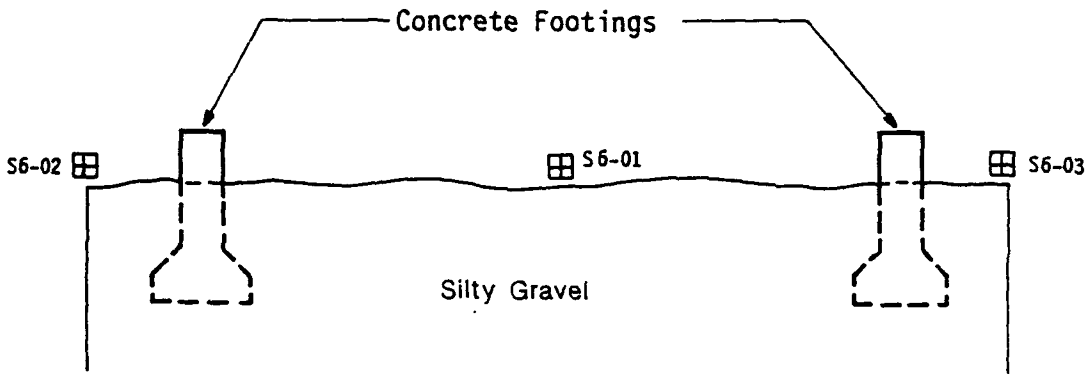
4.2.9.1.1.1 Records Review

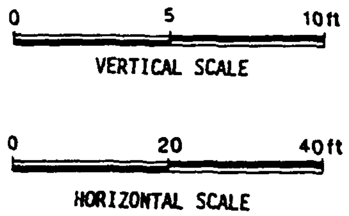
Due to the uncertainty of the location of Site S-6 prior to this study, records were reviewed to determine the location of the facility which had stored PCB-containing transformers. Based on conversations with Mike Grenko, the former Environmental Program Manager at Elmendorf AFB, 1965 air photos, and as-built drawings, the proper site was determined to be building 31-357 (Figure 4.2.9.1). The building was found to have been demolished, although the concrete foundation and loading dock remained.



LOCATION MAP
SITE S-6

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.9.1





Legend:

S6-01 ⊞ Stage 3 Borehole

Notes:

1. Horizontal scale: 1 inch = 20 feet.
2. Vertical scale: 1 inch = 5 feet.
3. Geologic cross section shown on Figure 4.2.9.3
4. Water table is below a depth of 5 feet.

GEOLOGIC CROSS SECTION
SITE S-6

IRP Stage 3 RI/FS **Elmendorf AFB, AK**	**Figure** 4.2.9.2

4.2.9.1.1.2 Shallow Soil Borings

Six shallow soil borings were drilled at the site, each to a depth of 5 feet (Figure 4.2.9.1). A log for each boring is presented in Appendix C.

4.2.9.1.2 Site Hydrogeology

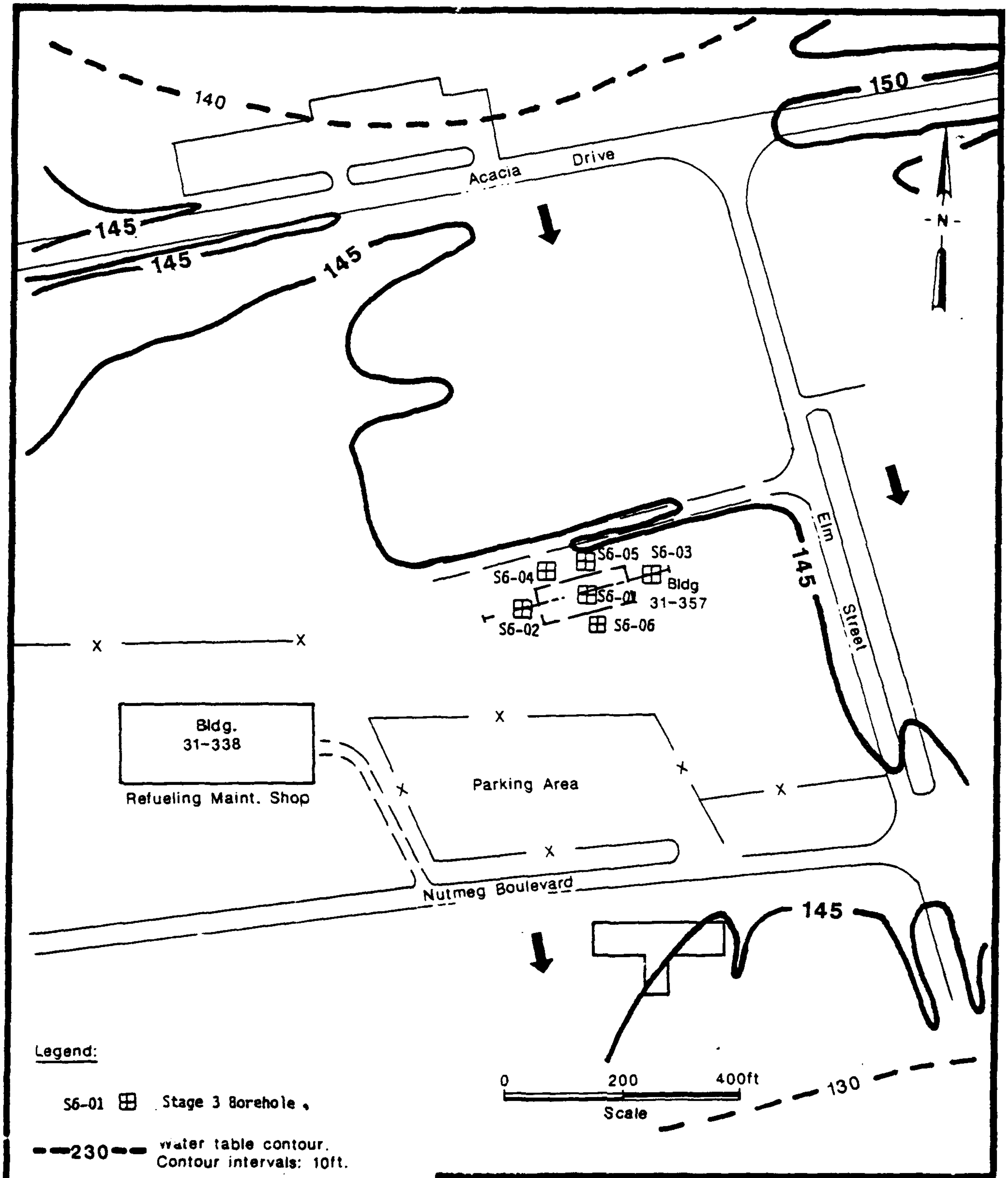
Site S-6 is underlain by sands and gravels with some silt. The water table was at a depth of approximately 10 feet. The direction of groundwater flow, based on regional trends (Figure 4.2.9.3), is toward the south with a gradient of approximately 45 feet per mile. Because borings at the site penetrated only 5 feet below land surface and may not be representative of aquifer material, hydraulic conductivities at the site are essentially unknown.

4.2.9.1.3.1 Field Analytical Results and Observations

During the coarse of drilling the shallow soil borings, no petroleum odors or HNu readings above background were noted. There were no obvious visible stains on the ground or concrete.

4.2.9.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site S-6 is presented on Table 4.2.9.1, and the sample plan for the base-wide field investigation program is included in Appendix B. Aroclor 1260 was the only contaminant identified from the laboratory analysis of samples collected at Site S-6. The analyte concentration is plotted next to the corresponding test boring on Figure 4.2.9.4. Sampling depth is included for the soil samples. Isoconcentration lines were not drawn



Legend:

S6-01 ⊞ Stage 3 Borehole

— —230— — Water table contour. Contour intervals: 10ft.

Approximate direction of groundwater flow.

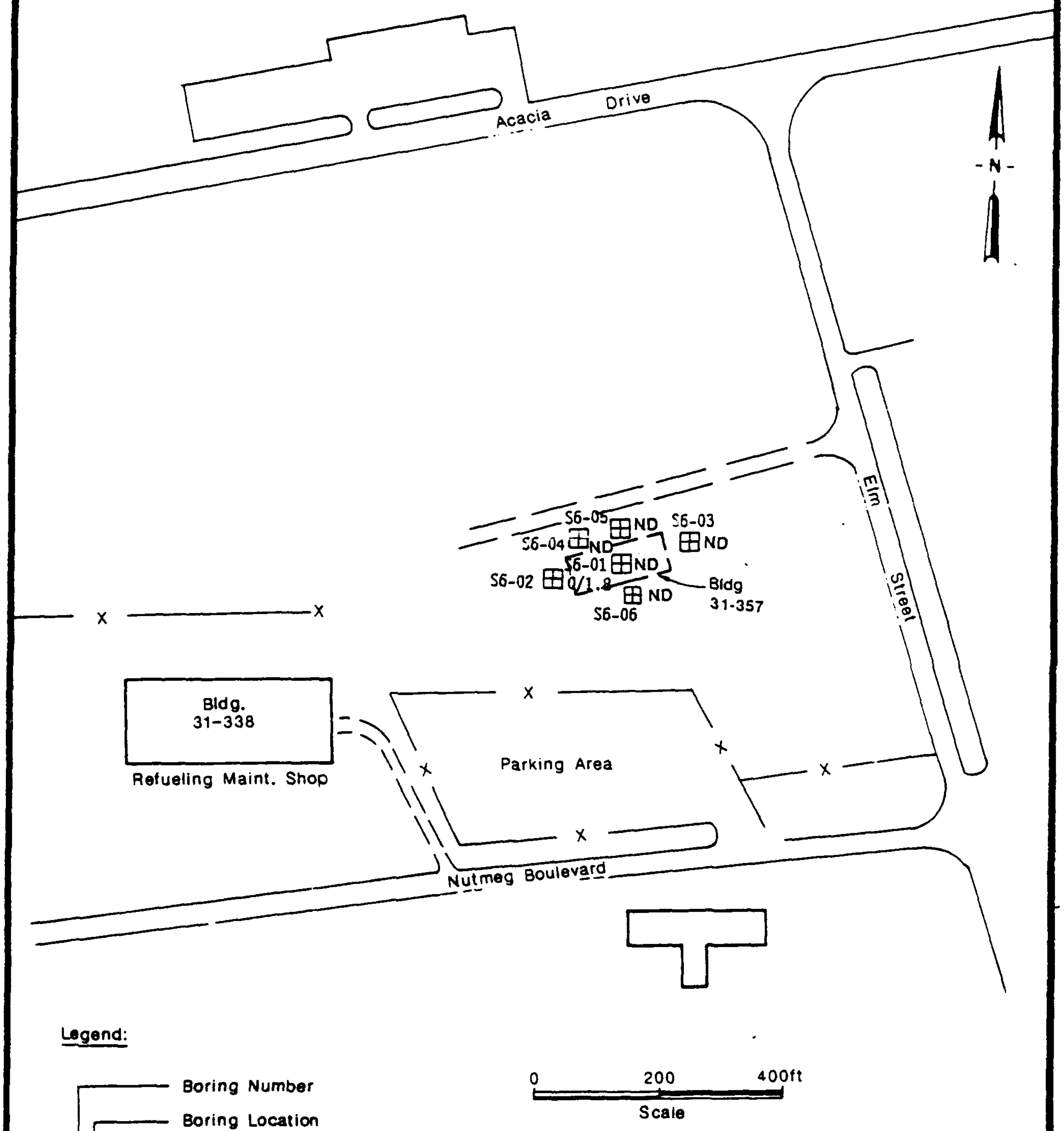
—300— Landsurface elevation contour. Contour intervals: 5ft.

Geologic Cross Section

HYDROGEOLOGIC MAP
SITE S-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.9.3



Legend:

S6-01 ⊞ 10/300

- Boring Number
- Boring Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: µg/L
  - ND: Non-Detected

S6-01 ⊞ Stage 3 Borehole

Note: Water sample concentrations not associated with a depth.

AROCLOR-1260
CONCENTRATION
SITE S-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.9.4

due to the few points having detectable contamination for each analyte. Results of analytical tests for metals and other contaminants are presented in Table 4.2.9.2.

Table 4.2.9.1 Requested Analyses for Laboratory Samples at Site S-6

SOIL/SEDIMENT

Test Number	Analysis
8080	Organochlorine Pesticides and PCBs
160.3	Soil Moisture Content

4.2.9.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site S-6 are presented on Table 4.2.9.2.

4.2.9.1.5 Discussion of Analytical Data

Aroclor 1260 was the only contaminant detected in soil samples from Site S-6 (Figure 4.2.9.4). This compound was detected in a composited soil sample from boring S6-02 at a concentration of 1.8 mg/kg.

4.2.9.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site S-6 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.9.2.1 Loss of Samples

No soil samples collected for laboratory analysis were lost from Site S-6.

Table 4.2.9.2

Analytical Results - Site S-6

Parameter	Method	Units	Standards, Criteria and Action Levels: Federal	State	S6-01 0'-5' 0687-SO-043 GS-88-0001 001170-0009	S6-02 0'-5' 0687-SO-044 GS-88-0001 001170-0010	S6-03 0'-5' 0687-SO-045 GS-88-0001 001170-0011	S6-04 0'-5' 0687-SO-046 GS-88-0001 001170-0012	S6-05 0'-5' 0687-SO-047 GS-88-0001 001170-0013	S6-06 0'-5' 0687-SO-048 GS-88-0001 001170-0014
Total Solids	160.3	%			96.9	96.6	96.7	96.4	95.6	96.4
Aroclor 1260	8080	mg/kg		10*		1.8				

* For spills that occured after 1987.

4.2.9.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during soil sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in samples from the site.

4.2.9.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Six soil samples were collected from 6 shallow borings at Site S-6. No out-of-control conditions occurred during drilling operations at the site. Holding times were not exceeded for any tests completed on the soil samples.

4.2.9.3 Significance of Findings

Analytical results showed contamination by the polychlorinated biphenyl (PCB) Aroclor 1260 in a composite sample from borehole S6-02. This contamination was detected at a concentration of 1.8 mg/kg. The method detection limit for Aroclor 1260 is 1.6 mg/kg. State of Alaska regulations for this compound in soil are 10 mg/kg in an uncontrolled area. Observations recorded in the field did not show the presence of petroleum product, by visual observation, an odor, or HNu levels above background. None of the 6 test borings completed at the site reached the water table.

Transformers stored in a building at Site S-6 are the probable source of Aroclor 1260 in the composite sample. Basic receptors are humans, wildlife, and plants. Pathways of exposure to the receptors include ingestion or handling of the contaminated surface soil, or surface water runoff.

4.2.9.3.1 Zones of Contamination

Only 1 of the 6 shallow boreholes drilled at the site was found to be contaminated with PCBs. This sample was from borehole S6-02, located to the west of the building pad. All other soil samples from the site registered below detection limits for PCBs. The soil samples were not tested for petroleum hydrocarbons, organic compounds, or metals.

4.2.9.3.2 Contaminant Migration

Drilling and sampling operations at Site S-6 reached only to a depth of 5 feet. This is above the depth of groundwater. Therefore, it is not possible from this investigation to determine if the groundwater is contaminated in the vicinity of Site S-6. Contamination of the groundwater from sources at Site S-6 is possible, but unlikely, since PCBs are not very soluble and low subsurface concentrations were detected in the soil. Groundwater in the vicinity of Site S-6 is at least 10 feet deep.

Contaminants are not expected to migrate through the process of surface water runoff since PCBs are not very soluble. No PCB product was encountered and vaporization of the compounds is not likely due to their low volatility.

4.2.9.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off-Base migration is unknown due to unconfirmed or unidentified subsurface hydrology conditions.

The direction of subsurface flow in the vicinity of Site S-6 is assumed to be to the south (Figure 4.2.9.3); however, this flow direction has not been confirmed. It is unlikely that contamination from Site S-6 has entered the groundwater.

Migration of contamination is unlikely through runoff water contaminated by PCBs in surface soils. Although runoff water could quickly exit the site and flow down the nearby road or storm drains, the low solubility of PCBs precludes this pathway.

4.2.9.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site inferred that the direction of groundwater flow is to the south. Horizontal hydraulic conductivity values are essentially unknown. The rate of migration of the contaminants in the groundwater will depend upon the point of release to the groundwater, actual flow rates, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of migration rate of these chemicals.

4.2.9.3.2.3 Time of Travel to Receptors

The primary receptors at present are humans, wildlife and plants. Primary pathways are ingestion and handling of contaminated surface

soil and plants. Time of travel to receptors is immediate since surface soils are contaminated. The site is located in a developed area of base and is easily accessible. In addition, any surface runoff or accumulated precipitation may become contaminated by the soils. The surface runoff may flow downhill to a nearby road. Again, time of travel is negligible.

4.2.9.3.2.4 Applicability of Solute Transport Models

Solute transport models at Site S-6 are determined to be not applicable due to the low solubility of the compound and the low subsurface concentrations detected. It is unlikely that the groundwater is contaminated by PCBs based on the current site analytical data.

4.2.9.3.2.5 Expected Spatial and Temporal Variations in Concentration

Since groundwater in the area of this site was not sampled as part of this study, the spatial variations in the contamination levels of the groundwater is unknown. It is unlikely that groundwater is contaminated. Contamination was detected in a composite soil sample from borehole S6-02. All other soil samples were below detection limits for PCBs. There is no available temporal data for the site.

4.2.9.3.3.1 Waste Characterization

Aroclor 1260 was widely used in electrical transformers, but its use in the United States is now banned. This substance has been listed as a possible human carcinogen by the EPA.

4.2.9.3.3.2 Source and Release Characterization

Transformers stored in a building formerly located at the site constitute the source of PCBs at Site S-6. The scope of this study does not allow an accurate estimate of the volume of contamination released since exact records on the number of transformers stored in the building do not exist.

4.2.9.3.3.3 Fate and Transport of Contaminants

The fate of PCBs released to the environment at Site S-6 includes dispersion and dilution of the contaminants through runoff or ground water, and uptake by living organisms. Long-term degradation is unlikely to be important due to the high stability of PCB compounds.

Nonsoluble PCBs can be transported from the site through percolation to the saturated groundwater zone and subsequent migration along groundwater gradients. Additional transport can occur in the form of surface runoff. Contaminated soil from the site can be transported through human intervention.

4.2.9.3.3.4 Exposure Pathways

The exposure pathway for humans and wildlife is contact with or ingestion of contaminated soils. A secondary pathway is the ingestion of plants that have taken up contaminated surface water.

4.2.9.3.3.5 Identification of Receptors

Receptors are humans, wildlife, and plants. The site is located in a developed area of the base and is easily accessible. There are many buildings and roads in the vicinity of the site and wildlife is not expected to be abundant.

4.2.9.3.3.6 Carcinogenic Risks

The PCB Aroclor 1260 was detected in a surface soil sample at Site S-6. This compound has been listed as a carcinogen by the EPA.

4.2.9.3.3.7 Threat to Wildlife

A threat to wildlife exists through contact with contaminated surface soils, plants, or surface water runoff from the site. However, due to the concentration of Aroclor 1260 detected and the developed nature of the area surrounding the site, this threat is assessed as low.

4.2.9.3.3.8 No Threat to Human Health

The concentration of Aroclor 1260 was detected at a level just 0.08 mg/kg over the method detection limits and was detected in only 1 borehole. In addition, PCB's are not mobile, so exposure to PCBs should be limited. The threat to human health at Site S-6 is assessed as minimal.

4.2.9.4 Prioritization of Sites for Remedial Alternatives (S-6)

Site S-6 is recommended for no further action because Aroclor 1260 was detected in only one borehole at a concentration of 1.8 mg/kg which is less than the State of Alaska limit of 10 mg/kg.

4.2.10 Discussion of Results for Site SP-1, Diesel Fuel Line Leak

Site SP-1 is adjacent to 3 underground POL lines and is the location of a diesel fuel line leak between 1956 and 1958 (Figure 4.2.10.1). The amount of fuel spilled is unknown, but thousands of gallons of diesel fuel were recovered during the late 1950's. An unknown amount of fuel may remain below ground.

4.2.10.1 Presentation of Results at Site SP-1

Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site map.

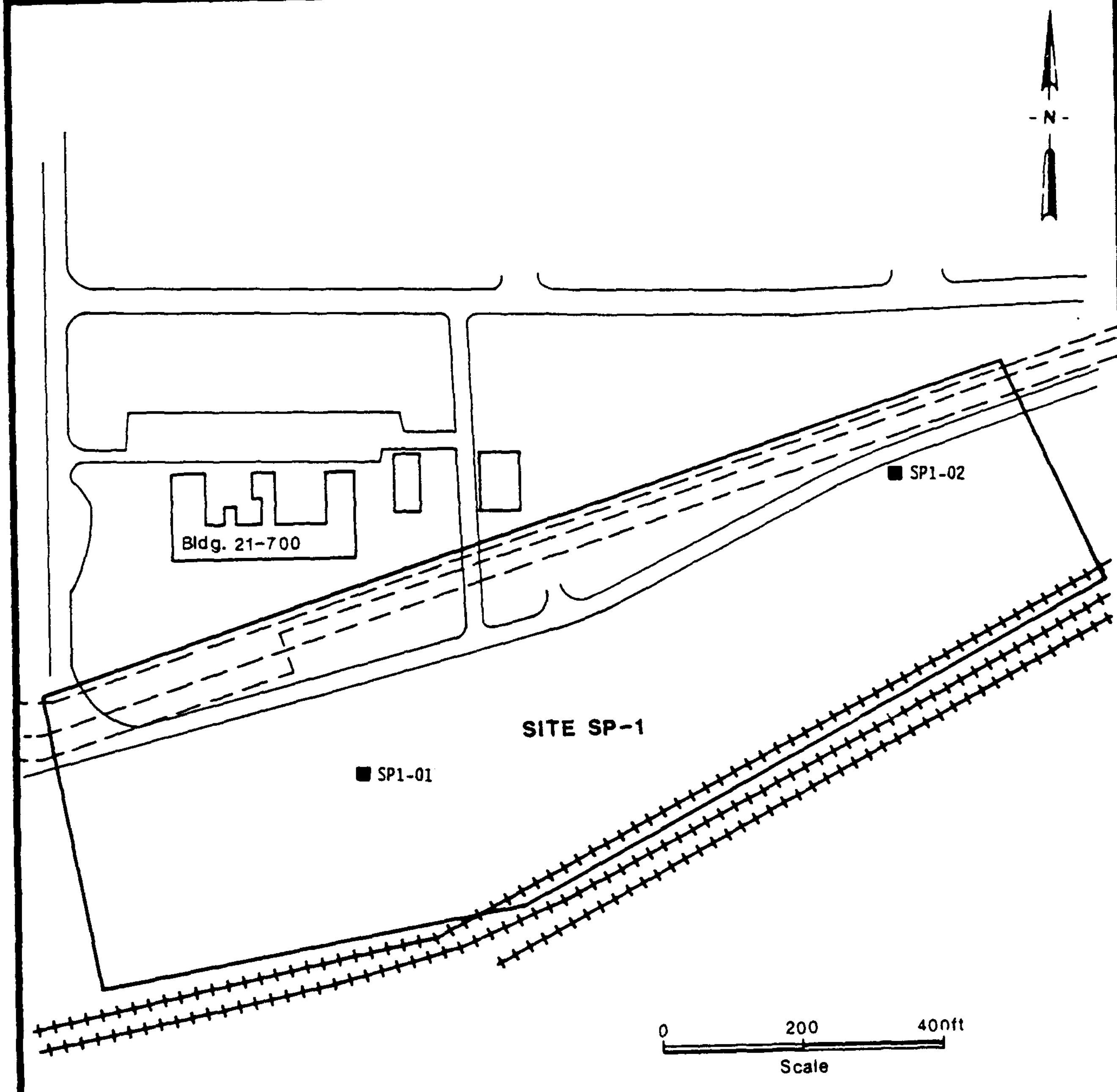
4.2.10.1.1 Site Geology

Site SP-1 is located on a south-facing bluff above the Ship Creek floodplain. The elevation ranges from 80 to 140 feet. The site slopes steeply and is generally composed of fill including apparent coal fly ash (a waste product from the nearby power plant), gravel, sand, silt, clay and concrete. The site is underlain at greater depth by fine-grained units of the Bootlegger Cove Formation. The site is heavily timbered with cottonwoods, and alders, birch and spruce trees.

Two borings were drilled at the site and completed as monitoring wells. Boring logs are presented in Appendix C. An interpreted gamma log of well SP-01 is included in Appendix D. A schematic geologic cross section is provided on Figure 4.2.10.2.

4.2.10.1.2 Site Hydrogeology

Site SP-1 is underlain by fill consisting of coal fly ash and a heterogeneous mixture of gravel, clay, silt, sand, concrete and



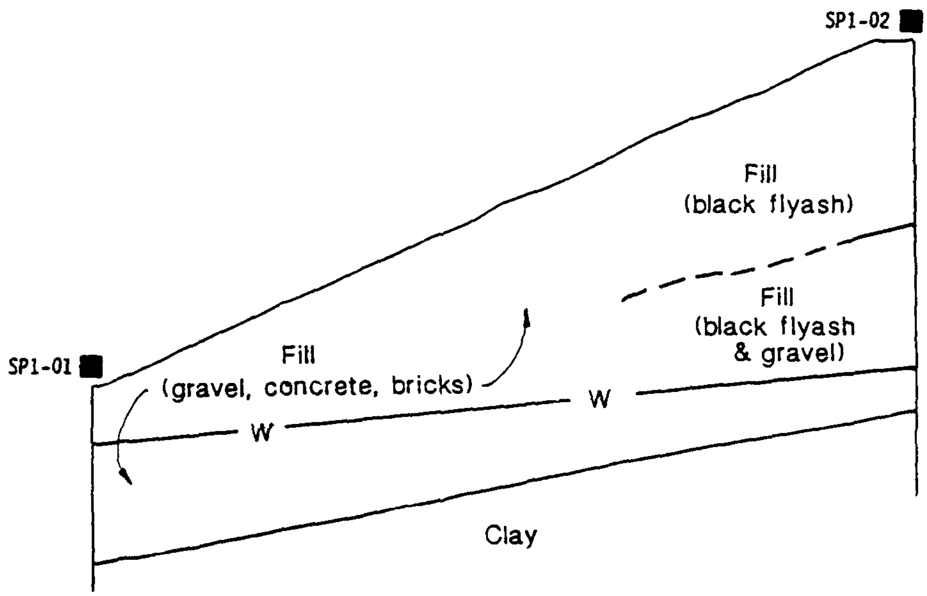
Legend:

SP1-01 ■ Monitoring Well Location
Stage 3

++++++++ Railroad

LOCATION MAP
SITE SP-1

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.10.1



Legend:

SP1 -01 ■ Monitoring Well Location Stage 3

—W— Projected Water Table

— — — Geologic Contact, Dashed Where Inferred

Notes:

1. Horizontal scale: 1 inch = 200 feet.
2. Vertical scale: 1 inch = 20 feet.
3. Geologic cross section shown on Figure 4.2.10.3

0 200 400ft

HORIZONTAL SCALE

0 20 40ft

VERTICAL SCALE

GEOLOGIC CROSS SECTION
SITE SP-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.10.2

bricks. This fill is underlain by clayey units of the Bootlegger Cove Formation. Groundwater flows south-southeast through the steeply sloping site with a gradient of approximately 1000 feet per mile (Figure 4.2.10.3). No slug tests were conducted at this site; thus, hydraulic conductivity values at this site are unknown.

4.2.10.1.3 Analytical Results

Field analytical results and observations, and laboratory analytical results are discussed in the following sections.

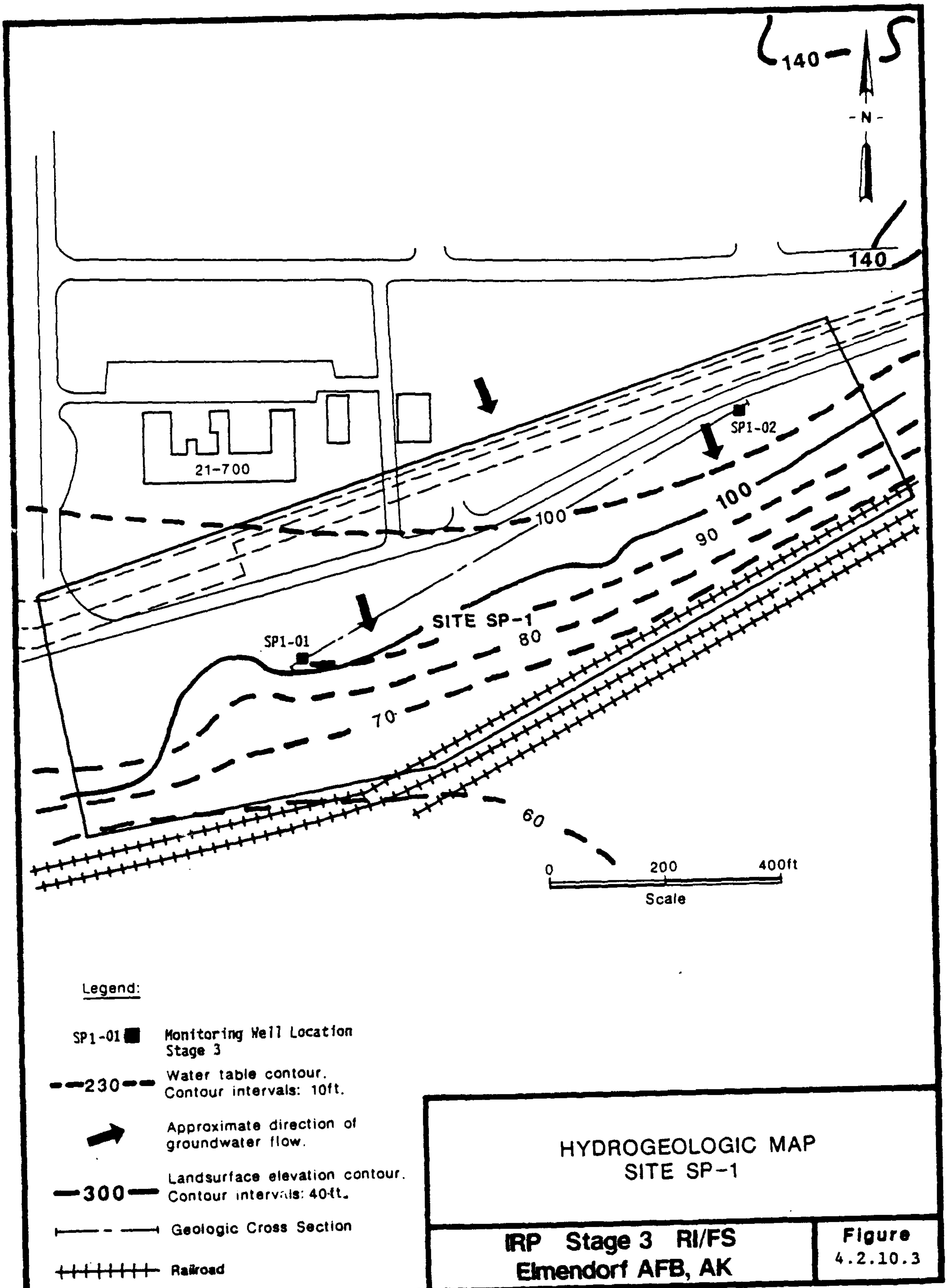
4.2.10.1.3.1 Field Analytical Results and Observations

Results of a soil gas survey conducted at Site SP-1 are presented on Figure 4.2.10.4 and in Table 4.2.10.1. Isoconcentration contours have been drawn based on the findings of the field analysis. In addition to the soil gas survey, the following visual observations were made in the field while drilling the wells:

- Well SP-01 - An HNu reading of 17 ppm was taken on a soil sample at 5 feet. A petroleum odor was present.

- Well SP1-02 - The following HNu readings were taken on soil samples:
  40 feet - 17 ppm (odor)
  42 feet - 45 ppm (odor)
  47 feet - 12 ppm (slight odor)
  50 feet - 20 ppm (slight odor)

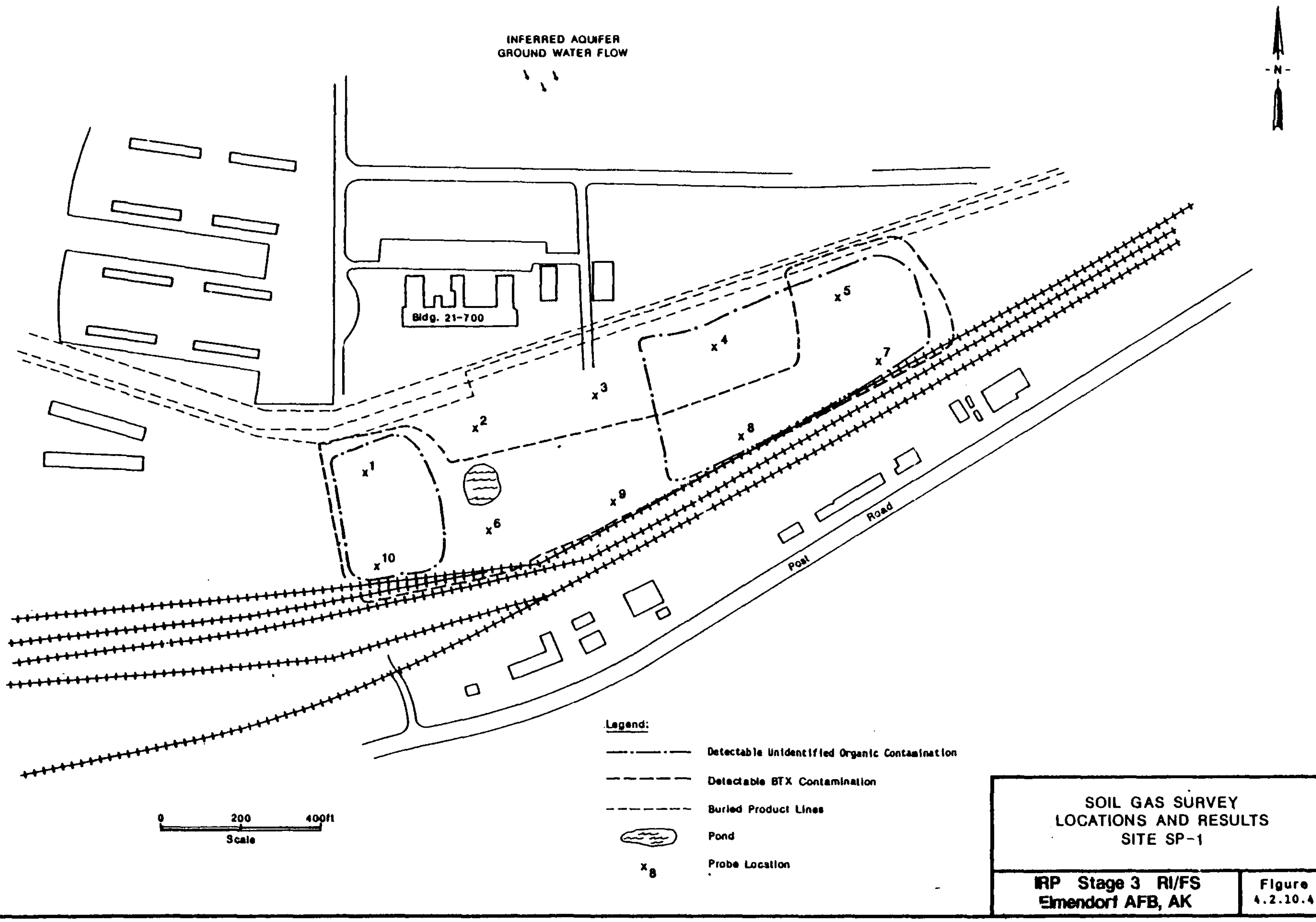
Field parameters measured at Site SP-1 during groundwater sampling are presented in Table 4.2.10.2.



HYDROGEOLOGIC MAP
SITE SP-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.10.3



SOIL GAS SURVEY
LOCATIONS AND RESULTS
SITE SP-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.10.4

4.2.10.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site SP-1 is presented in Table 4.2.10.3, and the sample plan is included in Appendix B. Major petroleum-based contaminants identified from the laboratory analysis of samples collected at Site S-1 are plotted on Figures 4.2.10.5

Table 4.2.10.1 Summary of Soil Gas Chromatograph Analyses at Site SP-1

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)	Comments
1	8.5	-	.34	.92	2.72	Unidentified organics
2	10	-	-	TR	TR	at 1.6 RT
3	6	-	TR	-	TR	
4	10	-	TR	TR	.22	
5	10	-	.19	-	.13	
	15	-	-	1.11	.06	
6	10	-	1.05	1.15	-	
7	10	-	-	.02	.73	
8	10	-	.17	-	.15	
9	10	-	9.98	TR	-	
10	10	-	2.21	1.86	.25	
Head Space		-	.30	.31	-	Water in pond

Note: Unidentified organics are reported in benzene equivalent ppm.

TR - Trace

RT - Retention Time

Table 4.2.10.2 Field Parameters Site SP-1

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
SP1-01	8/22/88	9.0	400	6.92	274	Slight POL odor,sheen
SP1-02	8/22/88	8.0	340	7.19	187	Slight POL odor,sheen

Table 4.2.10.3 Requested Analyses for Laboratory Samples as Site SP-1

SOIL

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
D2216 (E160.3)	Soil Moisture Content

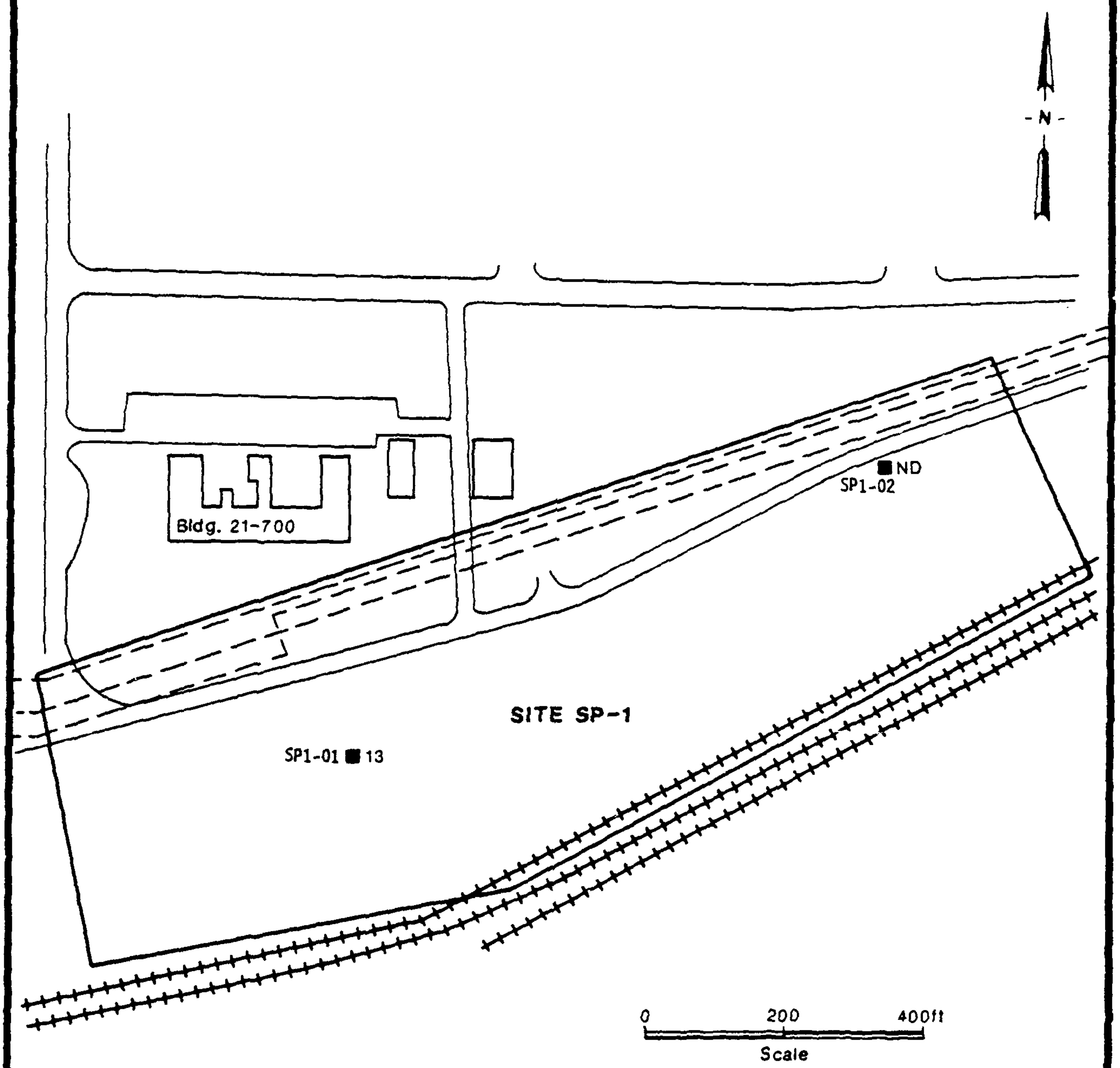
WATER

Test Number	Analysis
160.1	Total Dissolved Solids
418.1	Petroleum Hydrocarbons
602	Purgeable Aromatics
625	Extractable Priority Pollutants

through 4.2.10.9. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well. Sampling depths are included for the soil samples. Results of analytical tests are presented on Table 4.2.10.4.

4.2.10.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site SP-1 are presented in Table 4.2.10.4.



Legend:

SP1 -01 ■ Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

SP1 -01 (Sample) 10/300

[Soil: mg/kg
Water: µg/L
ND: Non-Detected]

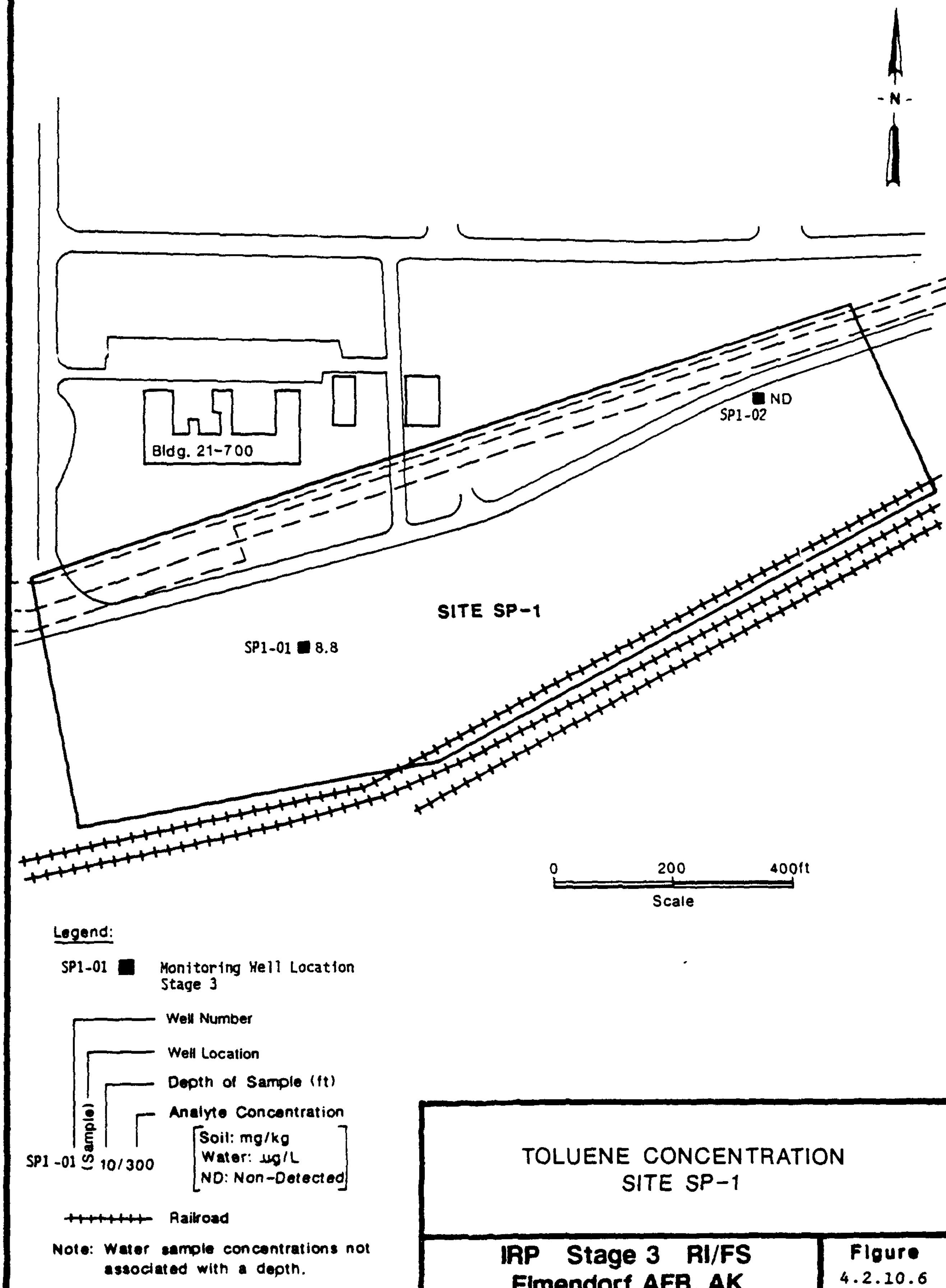
++++++++ Railroad

Note: Water sample concentrations not associated with a depth.

BENZENE CONCENTRATION
SITE SP-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

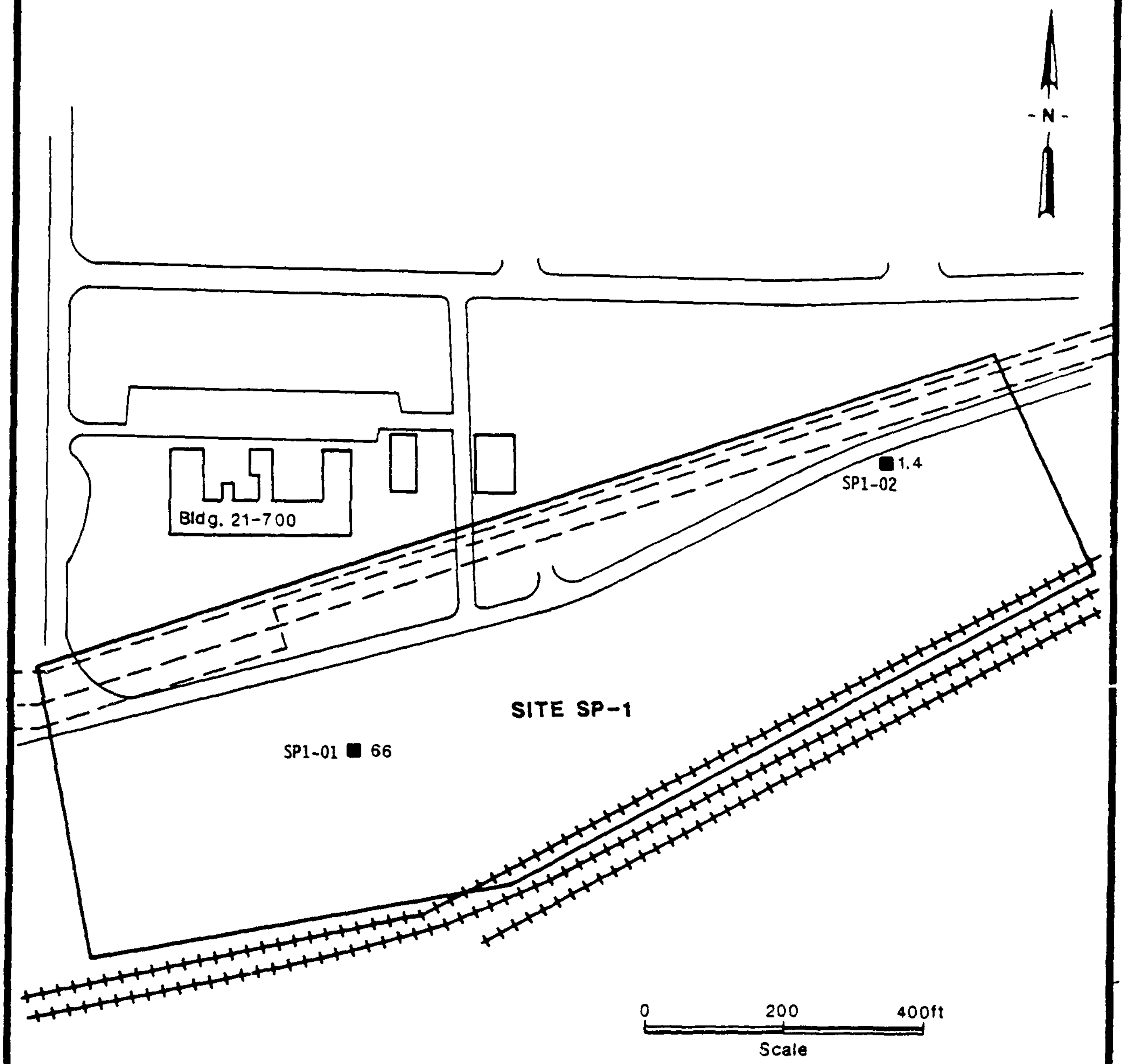
Figure 4.2.10.5



TOLUENE CONCENTRATION
SITE SP-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.10.6



Legend:

SP1-01 ■ Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

SP1-01 (Sample) 10/300

Soil: mg/kg
Water: µg/L
ND: Non-Detected

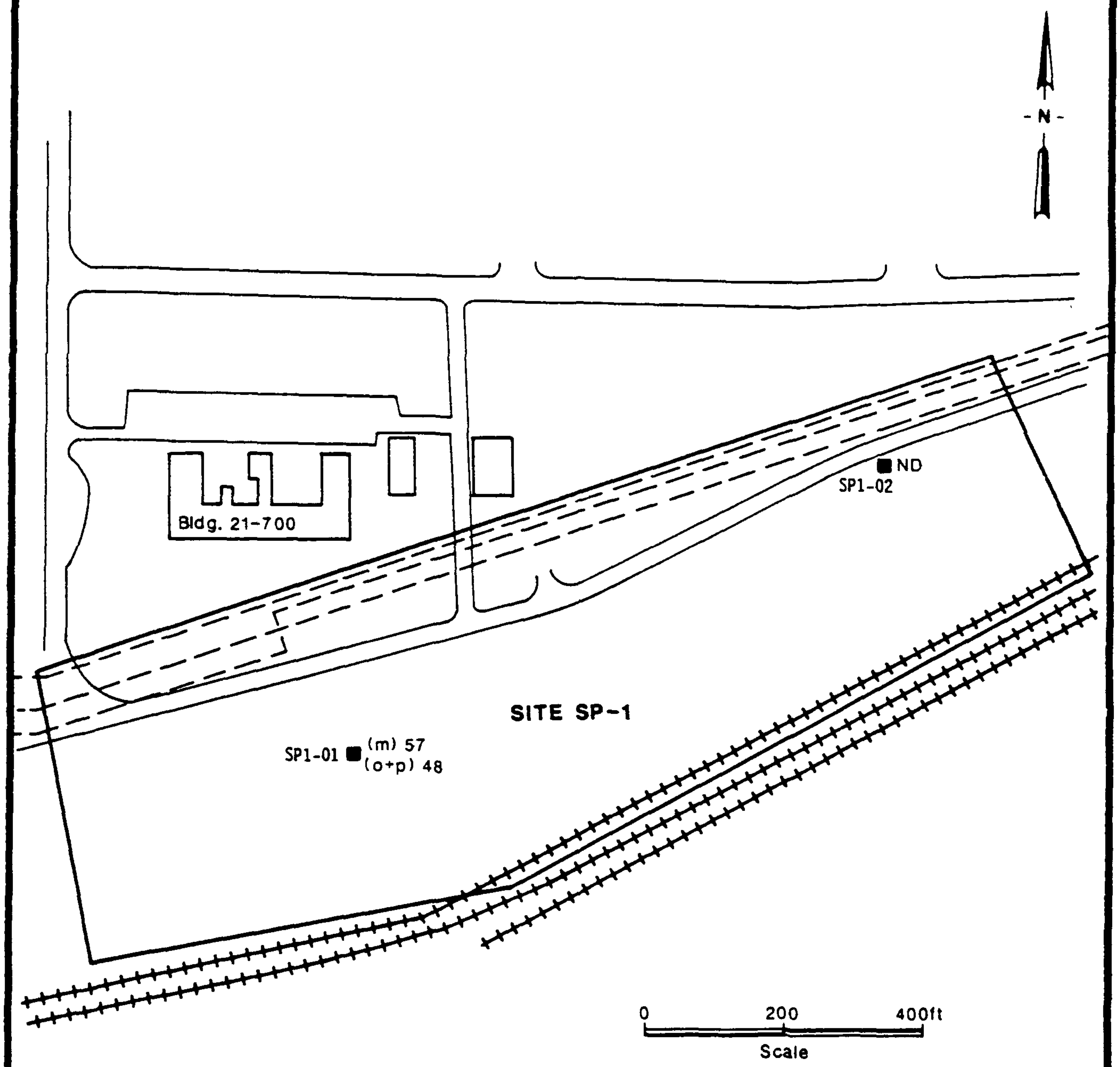
++++++++ Railroad

Note: Water sample concentrations not associated with a depth.

ETHYL BENZENE CONCENTRATION
SITE SP-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.10.7



Legend:

SP1-01 ■ Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

SP1-01 (Sample) 10/300

Soil: mg/kg
Water: µg/L
ND: Non-Detected

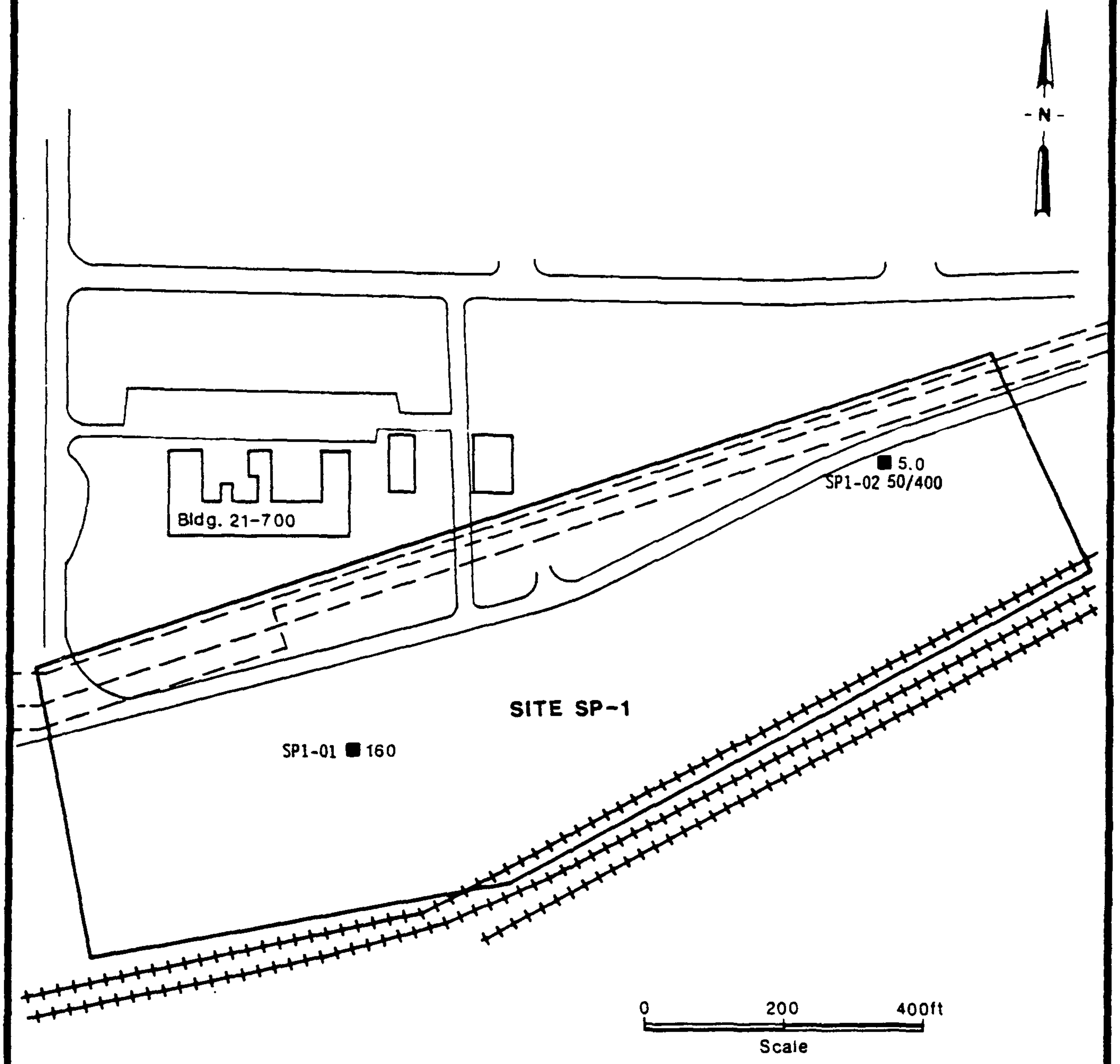
Railroad

Note: Water sample concentrations not associated with a depth.

(m), (o+p) XYLENE
CONCENTRATION
SITE SP-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.10.8



Legend:

SP1-01 ■ Monitoring Well Location Stage 3

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration
  - Soil: mg/kg
  - Water: mg/L
  - ND: Non-Detected

SP1-01 (Sample) 10/300

++++++++ Railroad

Note: Water sample concentrations not associated with a depth.

TOTAL PETROLEUM HYDROCARBON CONCENTRATION SITE SP-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.10.9

Table 4.2.10.4

Analytical Results - Site SP-1

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP1-01 0687-NG-049 GN-88-0003 001347-0010	SP1-01 5'-6.5' 0687-SO-049 GS-88-0001 001120-0001	SP1-01 20'-21.5' 0687-SO-049 GS-88-0002 001120-0002	SP1-02 0687-NG-050 GN-88-0003 001347-0011	SP1-02 DUPLICATE 0687-NG-050 GN-88-0003D 001347-0011
Benzene	EPA 602	ug/L	5.0	13.				
Ethyl benzene	EPA 602	ug/L	700	66.			1.4	1.3
Toluene	EPA 602	ug/L	2000	8.8				
Total Dissolved Solids	160.1	mg/L	500					
Total Petroleum Hydrocarbons	EPA 418.1			160.			5.0	4.0
Total Solids	160.3	%			81.7	73.2		
m-Xylene	EPA 602	ug/L	440	57.				
o & p-Xylene's)	EPA 602	ug/L	440	48.				

Table 4.2.10.4

Analytical Results - Site SP-1

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP1-02 40'-41.5' 0687-SO-050 GS-88-0001 001130-0006	SP1-02 50'-51.5' 0687-SO-050 GS-88-0002 001130-0007
Benzene	EPA 602	ug/L	5.0		
Ethyl benzene	EPA 602	ug/L	700		
Toluene	EPA 602	ug/L	2000		
Total Dissolved Solids	160.1	mg/L	500		402
Total Petroleum Hydrocaroons	EPA 418.1				
Total Solids	160.3	%		85.7	79.6
m-Xylene	EPA 602	ug/L	440		
o & p-Xylene(s)	EPA 602	ug/L	440		

4.2.10.1.5 Discussion of Analytical Data

Contamination by volatile organic compounds was encountered at Site SP-1 (Figures 4.2.10.5 through 4.2.10.9). Specifically, benzene, toluene, ethylbenzene, and xylenes (BETX) were identified in a water sample from the site. Total BETX in water from well SP1-01 was 192.8 ug/L. Total petroleum hydrocarbon concentration in this sample was 160 mg/L. Soil samples taken during drilling of this well were not contaminated. However, soil collected during the drilling of well SP1-02 was contaminated with petroleum hydrocarbons (400 mg/kg) at 50 feet. A water sample from well SP1-02 also contained petroleum hydrocarbons (5.0 mg/L) and ethylbenzene (1.4 ug/L).

4.2.10.2 Sampling or Analytical Problems

Sampling or analytical problems including loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan at Site SP-1 are addressed below.

4.2.10.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis from Site SP-1 were lost.

4.2.10.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in samples from the site.

4.2.10.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Two test borings were drilled at Site SP-1; both were completed as monitoring wells. Two soil samples and 1 water sample were collected from each well. No out-of-control conditions occurred during drilling or water sampling operations at the site.

4.2.10.3 Significance of Findings

Analytical methods detected organic compounds and petroleum hydrocarbons in soil and water samples from Site SP-1. Benzene was detected in water from well SP1-01 at a concentration of 13 ug/L which exceeds the State of Alaska Primary Drinking Water Standard of 5 ug/L. Toluene and ethylbenzene levels detected were below the regulatory limits. However, since water samples from wells SP1-01 and SP1-02 had petroleum odors and sheen, State of Alaska Drinking Water Standards for petroleum hydrocarbons were also exceeded.

Petroleum hydrocarbons from boring SP1-02, at a concentration of 400 mg/kg, exceeding the level suggested by the interim State of Alaska soil cleanup guidelines.

The source of petroleum hydrocarbons and associated volatile organics in the soil and water at this site is probably from leaks in the 3 underground POL and diesel lines adjacent to the site. The specific types and quantity of fuels spilled was never recorded.

Pathways of exposure are contact with and ingestion or uptake of contaminated ground or surface water. Receptors of the contamination are humans, wildlife, fish and plants.

4.2.10.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. A soil gas survey showed detectable BTX contamination over most of the site. Benzene was not detected at any of the soil gas probe locations, but toluene and xylenes were pervasive, especially at the base of the bluff north of the railroad. Two areas of unidentified organic contamination were also detected during the survey. Laboratory analyses of the water samples collected from wells SP1-01 and SP1-02 confirm the soil gas results for BTX contamination; both petroleum hydrocarbons and fuel related volatile organics were detected in water from both wells. Soil contaminated by petroleum hydrocarbons was only detected in samples from well SP1-02. A small pond located immediately to the west of well SP1-01 had a visible sheen in water that also had a petroleum smell. This water was not samped or analyzed.

General concentration lines have been constructed for the soil gas data, but there is insufficient data from other sources to allow three-dimensional temporal or higher-definition spatial mapping.

4.2.10.3.2 Contaminant Migration

Petroleum hydrocarbons and volatile organics are probably migrating in the groundwater. However, there are no wells downgradient from wells SP1-01 and SP1-02. The extent of migration past wells SP1-01 and SP1-02 is not known. However, the POL pipelines that are reportedly responsible for contamination at the site are upgradient from both wells SP1-01 and SP1-02. Therefore, the presence of detectable contamination in these wells and in the soil gas survey indicate a downgradient migration pattern.

4.2.10.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off-Base migration of contamination at Site SP-1 is unknown. Contamination was detected in wells SP1-01 and SP1-02 and a pond adjacent to well SP1-01 is visually contaminated and has a petroleum odor.

The soil gas survey detected contamination encompassing about 5 acres, covering areas to the south, east and west of the presumed leak site.

4.2.10.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site inferred that the direction of groundwater flow is to the south-southeast with a gradient of about 1000 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an exact estimate of the migration rate of the dissolved chemicals.

4.2.10.3.2.3 Time of Travel to Receptors

The primary receptors at present are humans, wildlife, fish and plants. Primary pathways are ingestion of contaminated ground and surface water. A secondary exposure route would be the ingestion of contaminated plants or fish. Ship Creek is located less than 500 feet southeast of Site SP-1. Hydraulic conductivity values have not yet been established for this site; thus, time of travel to the creek cannot be determined. However, any contamination reaching the creek is expected to become highly diluted within the creek water.

In addition, a small pond is located immediately to the west of well SP1-01. The water of this pond may be contaminated with petroleum products and may constitute an exposure pathway. Time of travel is negligible.

4.2.10.3.2.4 Expected Spatial and Temporal Variations in Concentration

Contamination by petroleum hydrocarbons was detected in only 1 soil sample collected at the site. The contamination was detected in a soil sample from 50 feet in well SP1-02.

The spatial extent of contamination in groundwater reaches to both wells SP1-01 and SP1-02, which are located about 40 and 200 feet downgradient from the pipeline, respectively. In addition, the soil gas survey detected contamination by BTX and solvents encompassing an area of about 5 acres. Although the actual leak sites are not known, the diesel fuel leak occurred somewhere along the POL pipelines located immediately north of the soil gas survey boundary. Therefore, it can be assumed that the contamination has covered at least a 5-acre area.

No wells were drilled at points north of the pipeline. Groundwater flow direction was predicted to be in a south-southeast direction; however, the decreased gradient at the top of the site (to the north and northwest) may alter the direction of flow, possibly allowing contamination from Site SP-1 to reach points north of the pipeline (Figure 4.2.10.3).

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates may be greatly changed by freezing and/or additional precipitation. Solubility of the contaminants is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.10.3.3 Baseline Risk Assessment

The contamination in relation to exposure routes, receptors, and health effects are evaluated in the following sections.

4.2.10.3.3.1 Waste Characterization

The primary wastes at the site are petroleum hydrocarbons and fuel-related volatile organics. Total petroleum hydrocarbons were detected in water samples at Site SP-1. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects. Benzene was detected in water from one well. This volatile organic is a known human carcinogen. Toluene and ethylbenzene were detected in water samples from the site. Xylenes are not considered to be highly toxic, but are narcotic at high concentrations.

4.2.10.3.3.2 Source and Release Characterization

Petroleum hydrocarbons and fuel-related volatile organics were released to the environment as the result of leaking POL pipelines north of the site. The amount and specific type of fuel spilled was never recorded. Recovery efforts in the late 1950's removed thousands of gallons of diesel fuel, but an unknown amount remains beneath the surface.

4.1.10.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons and fuel-related volatile organics released to the environment at Site SP-1 includes long-term natural degradation, dispersion of the contaminants through runoff, or uptake by living organisms. Another possible fate is the volatilization of fractions that have vapor pressures greater than 1 mm Hg.

Dissolved contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration

within the groundwater aquifer through the process of advection. Nonsoluble product will flow along the hydraulic gradient. Additional transport can occur in the form of surface runoff or release of vapor to the atmosphere. Contaminated soil or water from the site can be transported through human intervention.

4.2.10.3.3.4 Exposure Pathways

At present, the exposure pathway for humans, fish and wildlife is contact with or ingestion of contaminated ground or surface water, fish or plants.

4.2.10.3.3.5 Identification of Receptors

Receptors are humans, fish, wildlife and plants. Down-gradient off-base drinking water wells may be present. Human receptors include anyone ingesting the groundwater and/or coming in contact with possibly contaminated water in the pond adjacent to well SP1-01 or with Ship Creek water. Additional human receptors include anyone ingesting potentially contaminated fish. Plants in the area of this well may also become contaminated since surface and near-surface soils are contaminated with petroleum hydrocarbons.

4.2.10.3.3.6 Threat to Human Health

A possible threat to human health is contact or ingestion of water from the pond adjacent to well SP1-01 or the ingestion of plants in the vicinity of the pond. The pond is easily accessible from one of the larger housing units on the base.

Another threat to human health is the drinking of Ship Creek water, or the ingestion of fish from Ship Creek. The amount and type of contamination in the pond water has not been determined nor has the presence or absence of contamination been determined for Ship Creek

water immediately downgradient from the site. The threat to human health from Site SP-1 is not fully known.

4.2.10.3.3.7 Carcinogenic Risks

Benzene, a known human carcinogen, was detected in a water sample from well SP1-01. The concentration of benzene in the sample was 13 ug/L. This value exceeds the State of Alaska Primary Drinking Water Standard of 5 ug/L.

4.2.10.3.3.8 Threat to Wildlife

The site is in a heavily wooded area that may contain wildlife. Threat to wildlife is possible through ingestion of contaminated surface water. The pond adjacent to well SP1-01 and Ship Creek are the nearest surface water bodies. Since water from neither of these sources has been sampled nor analyzed for contaminants from the site, the threat to wildlife cannot be fully established.

Receptors and pathways are present and a possible threat to human health exists.

4.2.10.4 Prioritization of Sites for Remedial Alternatives

The site is close to a visually contaminated pond and privately-owned railroad tracks. There is potential for liability if contamination has spread under the tracks. Site SP-1 is recommended for high priority status due to the concentrations of petroleum hydrocarbons and benzene in water samples from this site.

Further work should include groundwater field screening probes in the area south of the railroad tracks and north of the POL pipelines. The survey will help to better define plume dimensions and will aid in selection of additional monitoring well locations. Five wells would be needed at this site. The previous 2 wells should be sampled. The water samples should be analyzed for total petroleum hydrocarbons,

purgeable aromatics and purgeable halocarbons. Purgeable halocarbons are not normally associated with diesel fuels, yet the soil gas survey detected unidentified organics which may be solvents. In addition, water samples should be collected from the contaminated pond. These samples should also be analyzed for petroleum hydrocarbons, purgeable aromatics and purgeable halocarbons. The soils collected from the new borings should be analyzed for TPH and VOCs.

4.2.11 Discussion of Results for Sites SP-2 and SP-6, Fuel Line Leak and Diesel Fuel Spill

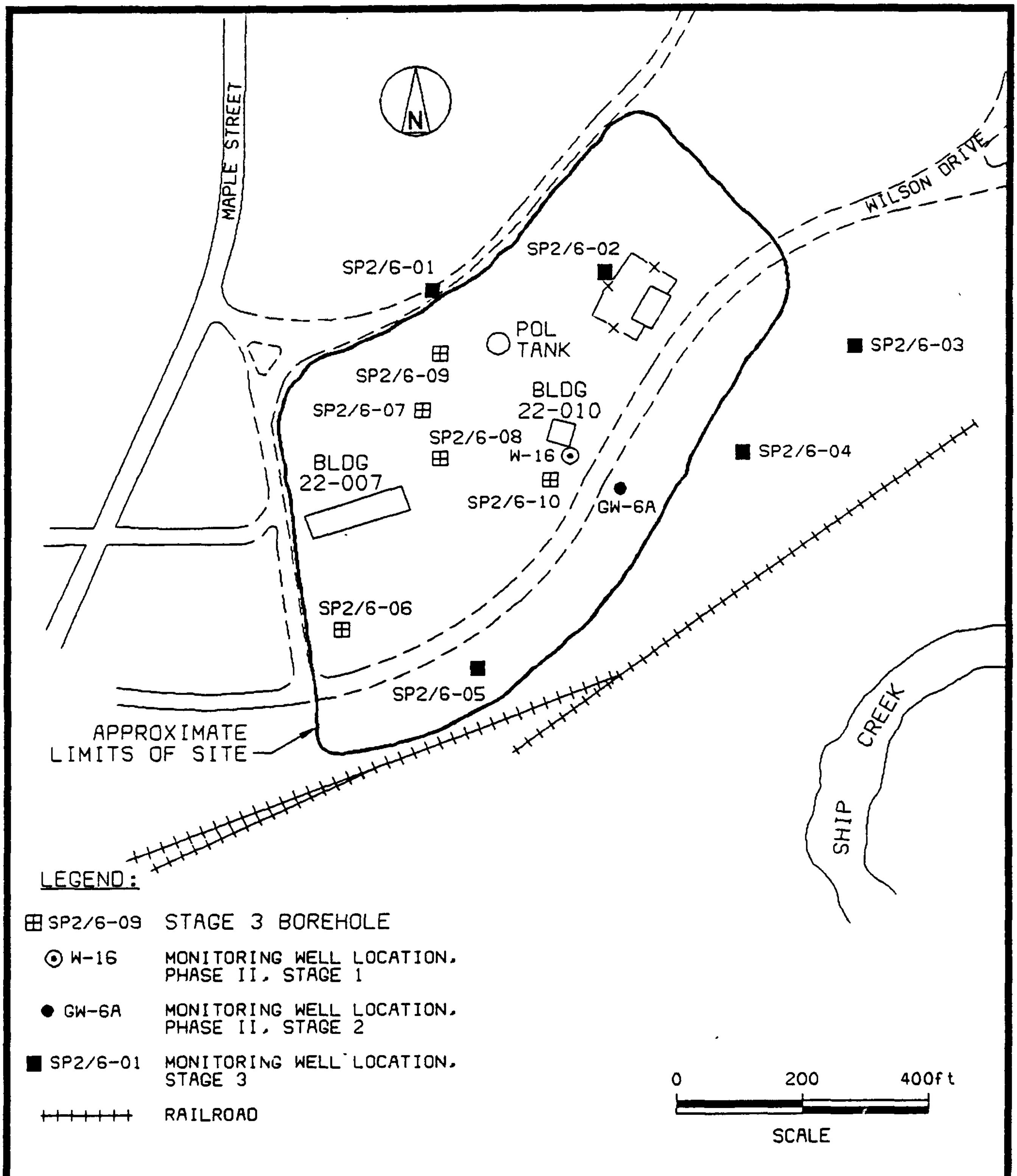
As a result of a fuel line leak at Site SP-2 during 1964-1965, an unknown quantity of JP-4 fuel seeped out of the bank southeast of building 22-010 and near a culvert crossing bluff road. Periodic JP-4 seeps have been noted in this area throughout the 1950's and 1960's (Harding Lawson, 1988). Site SP-6 encompasses building 22-013 and is adjacent to Site SP-2. An 8,000 gallon diesel fuel spill occurred at this site from an above-ground tank in the winter of 1976. Collection ditches were excavated in the ice and snow to channel the fuel from the 1976 spill to catchment basins for later removal by tanker truck. The ground was frozen at the time of the spill, and no substantial quantities of fuel were expected to have penetrated the ground surface. The sites have been combined and the total area for combined sites is indicated on Figure 4.2.11.1.

4.2.11.1 Presentation of Results for Site SP-2/6

Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site maps.

4.2.11.1.1 Site Geology

Site SP-2/6 is located at the top of a bluff on the north side of Ship Creek at an elevation ranging from 120-155 feet. The site terrain is uneven due to the construction of berms, roads, POL tanks, and other structures. The site is situated on coarse glacial outwash consisting chiefly of sands and gravels. Material at the south side of the site contains fill composed of coal fly ash. The coarse outwash deposits and the fill overlie finer-grained units of the Bootlegger Cove Formation at a depth of 50 feet or more. A schematic geologic cross



LOCATION MAP

SITES SP-2 & SP-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.11.1

section of the site is presented in Figure 4.2.11.2. Boring logs of 10 borings drilled at the site are presented in Appendix C. Interpretations of the two gamma logs are provided in Appendix D.

4.2.11.1.2 Site Hydrogeology

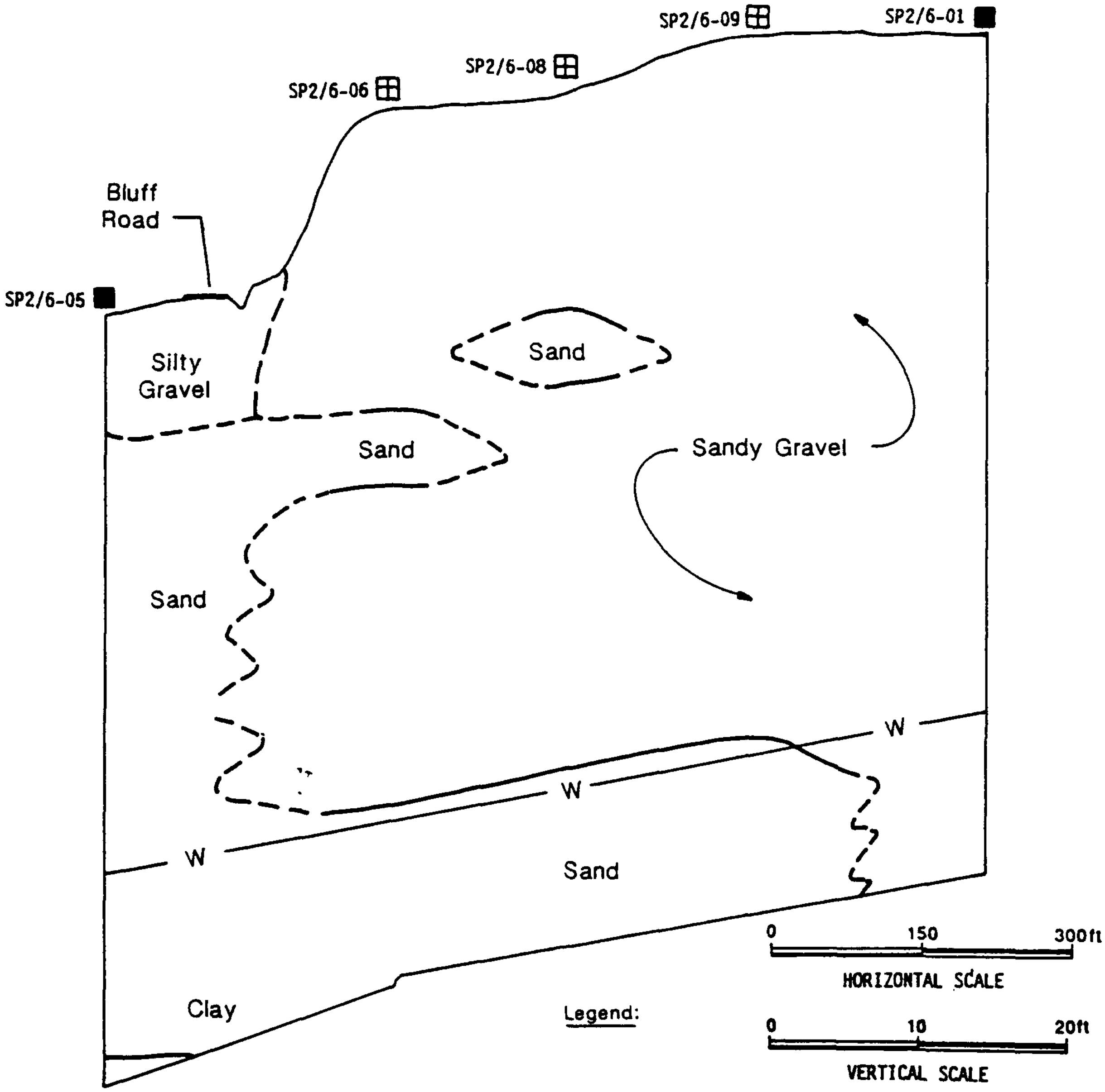
Site SP-2/6 is underlain by sands and gravels with some silts, clays and coal fly ash. The water table was at approximately 20 to 35 feet depth (Figure 4.2.11.3). The direction of groundwater flow is based on a comparison of regional trends and water level measurement at 7 wells at the site. The direction of groundwater flow is south to southeast with a gradient of approximately 130 feet per mile. Geologic deposits at the northern portion of the site are similar to deposits at the pump test site. Most deposits near Post Road in the southern portion of the site are somewhat finer-grained than deposits near the pump test site. Hydraulic conductivities will be lower where silts, clays and coal fly ash occur; however, accurate values have not yet been established.

4.2.11.1.3 Analytical Results

Field analytical results and observations, and laboratory analytical results are discussed in the following sections.

4.2.11.1.3.1 Field Analytical Results and Observations

Results of a soil gas survey conducted at Site SP-2 are presented in Figure 4.2.11.4 and in Table 4.2.11.1. Isoconcentration contours have been drawn based on the findings of the field analysis.



Legend:

—W— Projected Water Table

——— – – Geologic Contact, Dashed Where Inferred

SP2/6-01 ■ Monitoring Well Location Stage 3

SP2/6-09 ⊞ Stage 3 Borehole

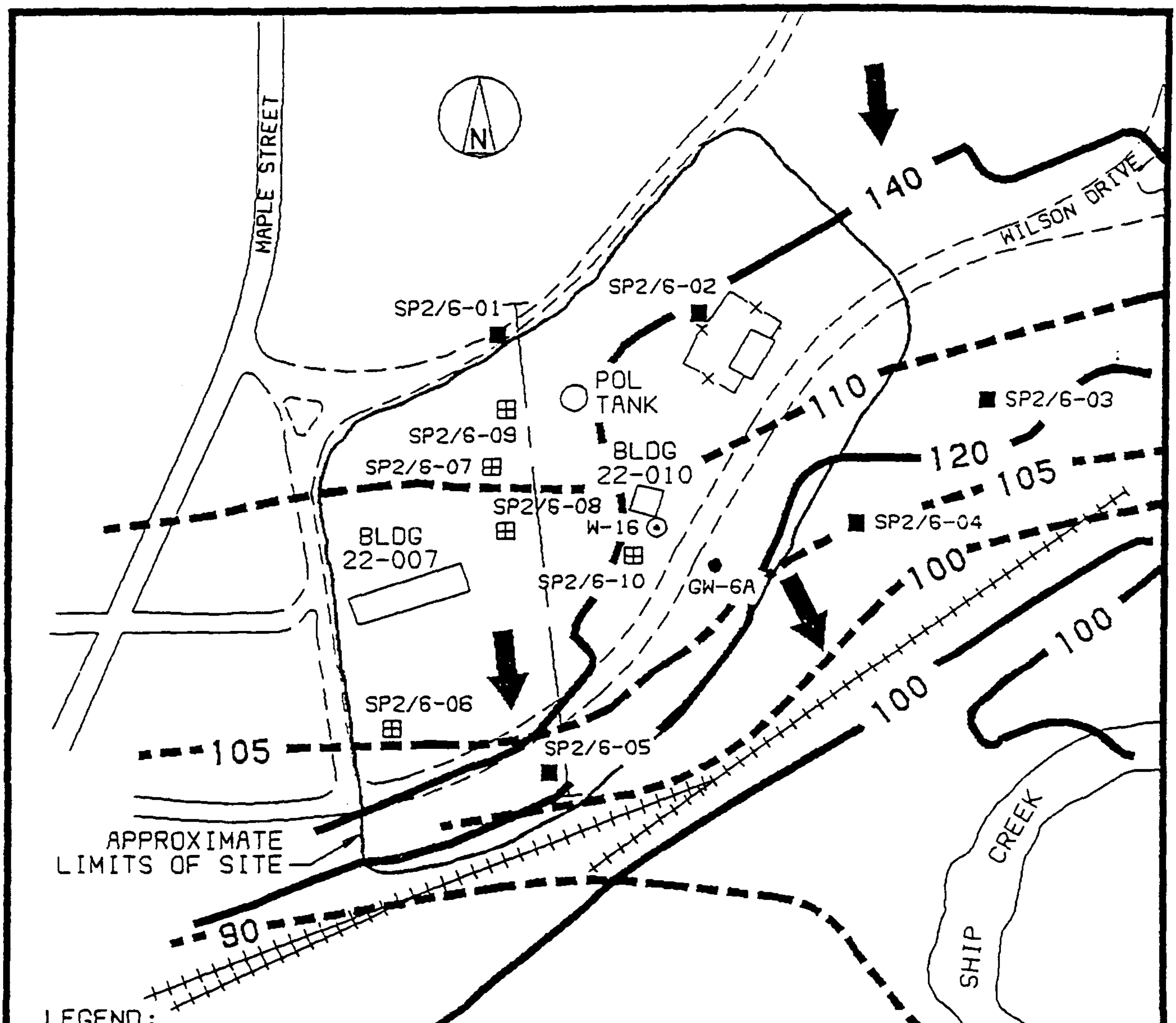
Notes:

1. Horizontal scale: 1 inch = 150 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Cross section location shown on Figure 4.2.11.3

GEOLOGIC CROSS SECTION
SITE SP-2 & SP-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.11.2



LEGEND:

⊞ SP2/6-09	STAGE 3 BOREHOLE
⊙ W-14	MONITORING WELL LOCATION, PHASE II, STAGE 1
● GW-4A	MONITORING WELL LOCATION, PHASE II, STAGE 2
■ SP4/11-03	MONITORING WELL LOCATION, STAGE 3
┼┼┼┼┼┼┼	RAILROAD
(arrow)	APPROXIMATE DIRECTION OF GROUNDWATER FLOW
■ ■ 120 ■ ■	WATER TABLE CONTOUR, 5' INTERVALS
━ 300 ━	LANDSURFACE CONTOUR, 20' INTERVALS
├── - - ──┤	GEOLOGIC CROSS SECTION

0 200 400ft

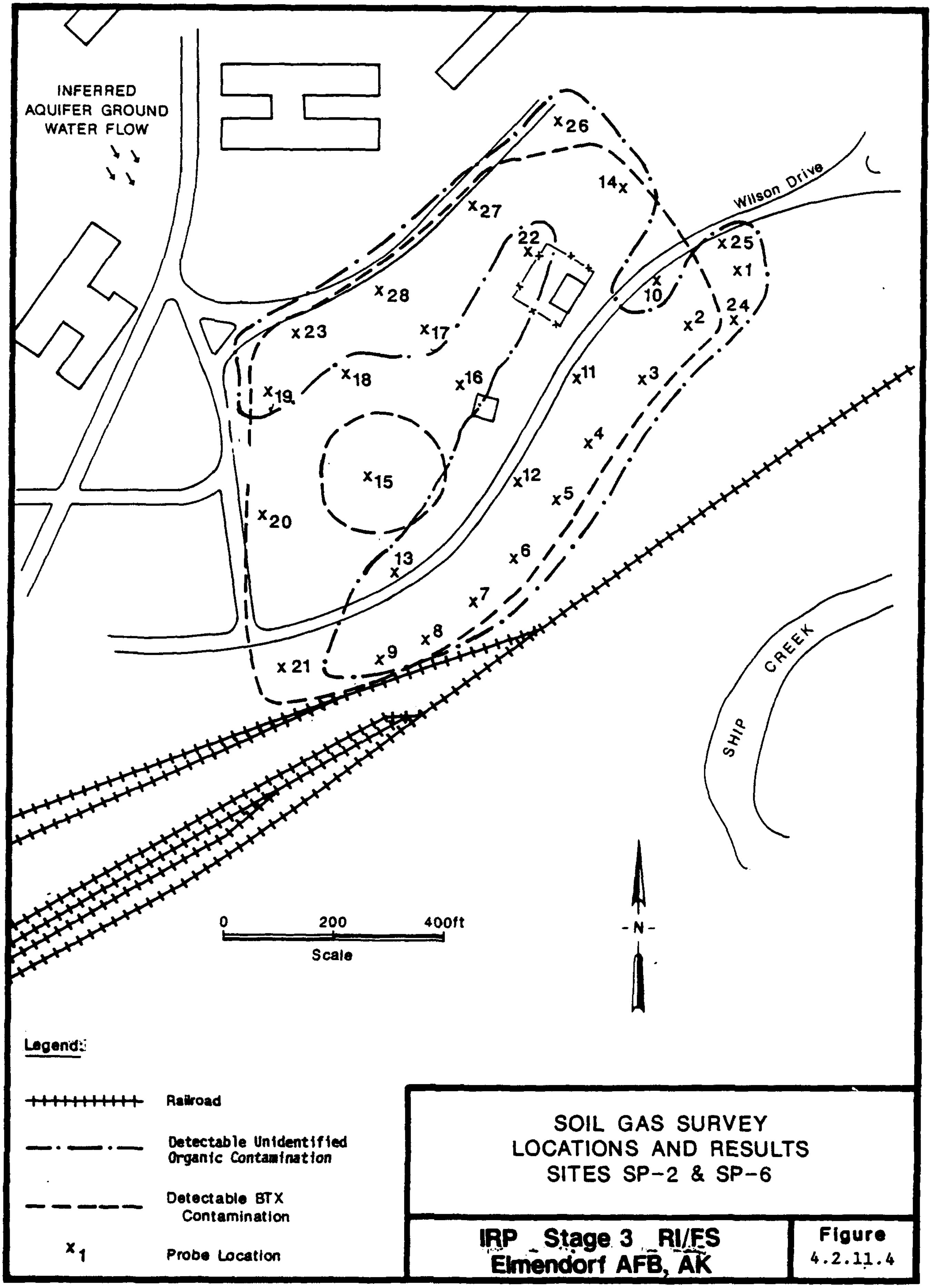
SCALE

HYDROGEOLOGIC MAP

SITES SP-2 & SP-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.11.3



SOIL GAS SURVEY
LOCATIONS AND RESULTS
SITES SP-2 & SP-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.11.4

Table 4.2.11.1 Summary of Soil Gas Chromatograph Analyses at Site SP-2/6

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)	Comments
1	10	-	TR	TR	.72	Unidentified organics at .95 RT
2	10	-	.83	TR	.34	
3	10	-	.77	3.14	.63	
4	10	-	.70	.47	.25	
5	10	-	1.14	TR	.52	
6	10	-	.31	-	.25	
7	10	.58	.31	-	.42	
8	10	-	.83	-	.31	
9	10	-	.19	TR	.18	
10	10	-	1.68	-	-	
11	5	.88	TR	-	.74	
	10	-	2.48	-	.80	
12	7	-	1.98	-	.87	
13	7.5	-	.34	-	.05	
14	9	-	.32	-	.22	
15	8	-	TR	-	-	
16	10	-	.08	-	-	
17	7.5	-	.89	-	.03	
18	7.5	.03	.05	8.91	-	Diesel
19	9	-	2.08	-	.25	
20	10	-	.57	-	-	
21	9.5	-	2.55	TR	-	
22	10	-	TR	7.97	-	
23	10	-	.24	TR	.06	
24	15	-	TR	TR	.63	
	20	-	TR	TR	.36	
25	10	-	TR	TR	.52	
26	10	-	TR	TR	TR	
27	10	TR	.26	-	.04	
28	10	TR	2.36	-	.10	

Note: Unidentified organics are reported in benzene equivalent ppm.
TR - Trace
RT - Retention Time

Evidence of probable contamination was recorded during the field investigation based on HNu readings, odor and visual evidence. The field observations are summarized herein:

- Well SP2/6-01:

Depth of Sample	HNu Readings on Soil Sample
30 feet	5 ppm (slight odor)
35 feet	1 ppm
40 feet	9 ppm

- Well SP2/6-02:

Depth of Sample	HNu Readings on Soil Sample
15 feet	2 ppm
20 feet	2 ppm

- Well SP2/6-04 - An HNu reading of 1 ppm was recorded on a soil sample taken at a depth of 5 feet

- Well SP2/6-05:

Depth of Sample	HNu Readings on Soil Sample
30 feet	750 ppm (odor)
40 feet	5 ppm (odor)

- Boring SP2/06:

Depth of Sample	HNu Readings on Soil Sample
15 feet	0.1 ppm
30 feet	0.2 ppm
50 feet	3 ppm

- Boring SP2/6-07:

Depth of Sample	HNu Readings on Soil Sample
15 feet	2 ppm
20 feet	1 ppm
25 feet	1 ppm
30 feet	6 ppm
35 feet	3 ppm
49 feet	0.5 ppm

- Boring SP2/6-08:

Depth of Sample	HNu Readings on Soil Sample
5 feet	5.5 ppm
20 feet	0.2 ppm
30 feet	0.1 ppm
37 feet	0.1 ppm
49 feet	5 ppm (odor)

- Boring SP2/6-10:

Depth of Sample	HNu Readings on Soil Sample
15 feet	0.1 ppm
30 feet	500 ppm (odor)
35 feet	10 ppm (odor)
40 feet	5 ppm (odor)

Field parameters measured at Site SP-2/6 during groundwater sampling are provided on Table 4.2.11.2.

4.2.11.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site SP-2/6 is presented in Table 4.2.11.3, and the sample plan for the base-wide field

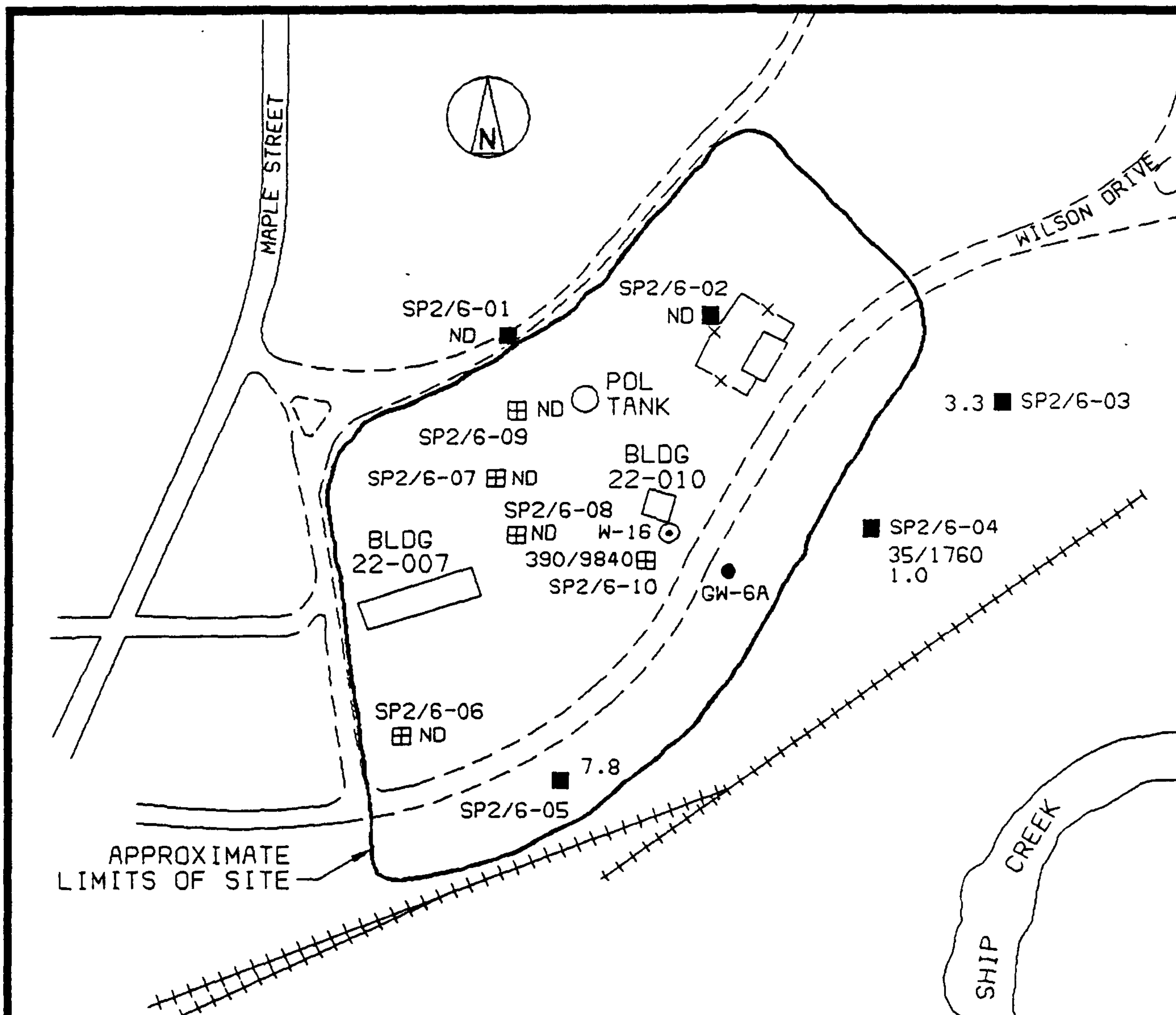
investigation program is included in Appendix B. Major petroleum-based contaminants identified from the laboratory analysis of samples collected at Site SP-2/6 are plotted on Figures 4.2.11.5 through 4.2.11.9. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well or test boring. Sampling depths are included for the soil samples.

Table 4.2.11.2 Field Parameters Site SP-2/6

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
SP2/6-1	8/10/88	8.2	360	7.09	240	No odor or sheen
SP2/6-2	8/10/88	9.0	345	6.96	236	Slight POL odor, sheen
SP2/6-3	8/13/88	7.2	700	7.07	227	Slight H2S odor only
SP2/6-4	8/13/88	7.0	320	6.98	64	Slight H2S odor only
SP2/6-5	8/16/88	9.0	345	7.02	224	Slight POL odor, sheen
W-16	8/10/88	9.5	360	7.00	248	Slight POL, H2S odors
GW-6A	8/10/88	8.0	340	7.03	246	Slight POL odor, sheen

Table 4.2.11.3 Requested Analyses for Laboratory Samples at Site SP-2/6

	Test Number	Analysis
SOIL		
	3550	Total Petroleum Hydrocarbons
	8240	Volatile Organic Compounds
	8270	Semi-volatile Organic Compounds
	D2216 (E160.3)	Soil Moisture Content
WATER		
	418.1	Petroleum Hydrocarbons
	602	Purgeable Aromatics
	625	Extractable Priority Pollutants



LEGEND:

SP2/6-09	STAGE 3 BOREHOLE
W-14	MONITORING WELL LOCATION, PHASE II, STAGE 1
GW-4A	MONITORING WELL LOCATION, PHASE II, STAGE 2
SP4/11-03	MONITORING WELL LOCATION, STAGE 3
	RAILROAD

BORING/WELL NUMBER
BORING/WELL LOCATION
DEPTH OF SAMPLE (ft)
ANALYTE CONCENTRATION

SOIL: mg/kg
WATER: mg/L
ND: NON-DETECTED

(SYMBOL) 10/300
SP2/6-01

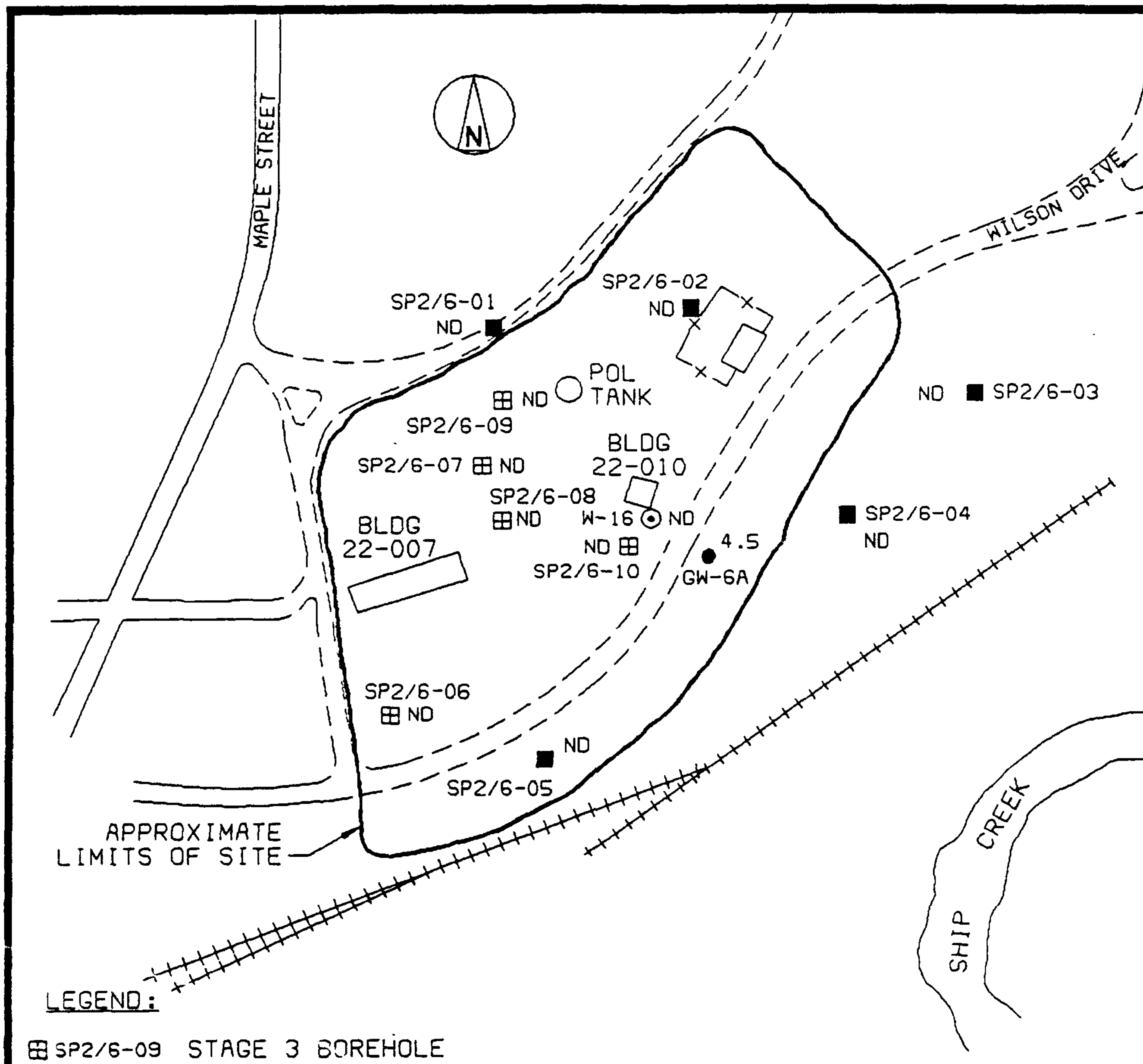
NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

0 200 400ft
SCALE

TOTAL PETROLEUM HYDROCARBON CONCENTRATION SITES SP-2 & SP-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.11.5



LEGEND:

SP2/6-09	STAGE 3 BOREHOLE
W-14	MONITORING WELL LOCATION, PHASE II, STAGE 1
GW-4A	MONITORING WELL LOCATION, PHASE II, STAGE 2
SP4/11-03	MONITORING WELL LOCATION, STAGE 3
	RAILROAD

BORING/WELL NUMBER
BORING/WELL LOCATION
DEPTH OF SAMPLE (ft)
ANALYTE CONCENTRATION

SOIL: mg/kg
WATER: mg/L
ND: NON-DETECTED

(SYMBOL)
10/300
SP2/6-01

NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

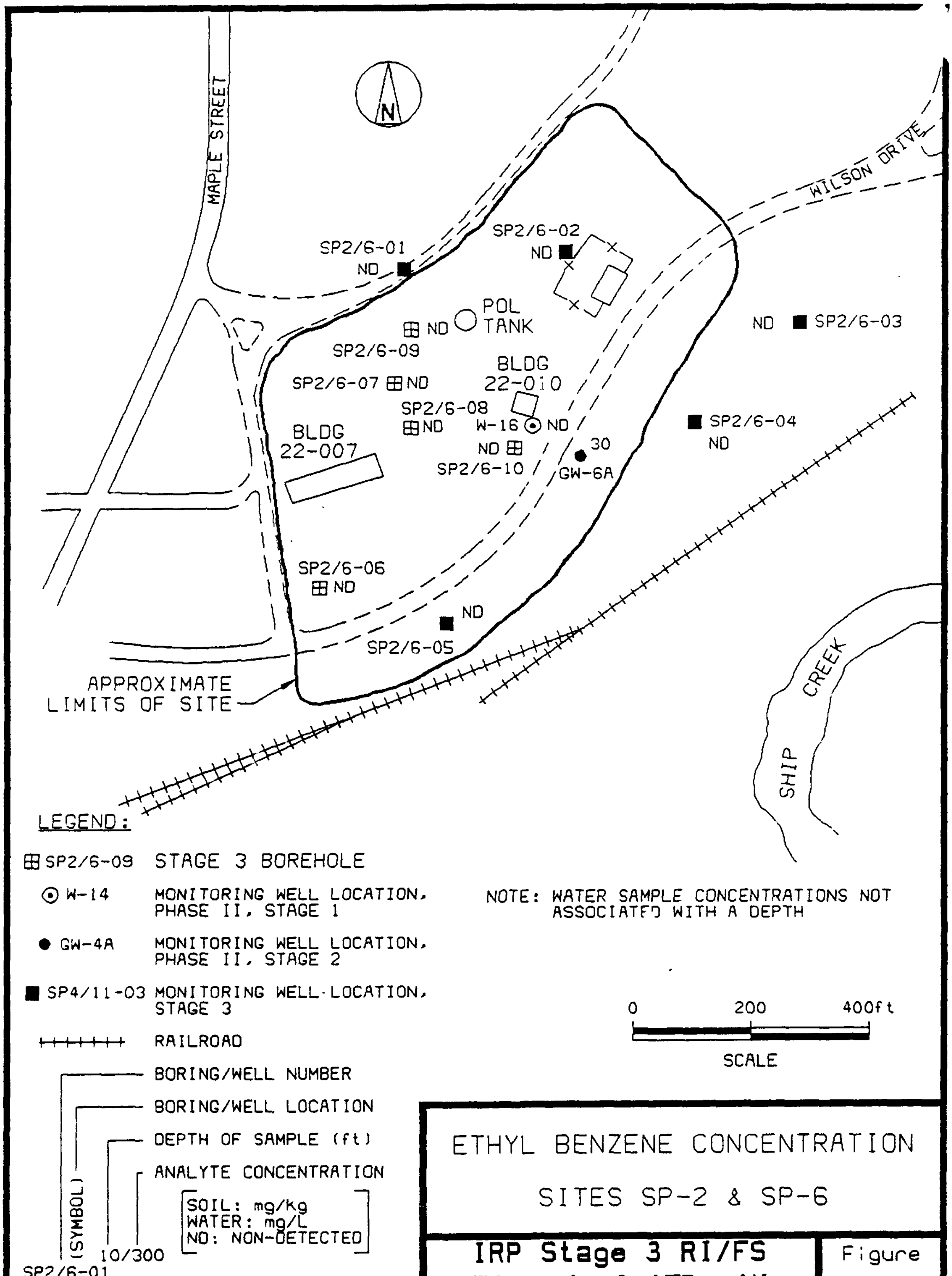
0 200 400ft
SCALE

TOLUENE CONCENTRATION

SITES SP-2 & SP-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.11.6



ETHYL BENZENE CONCENTRATION

SITES SP-2 & SP-6

IRP Stage 3 RI/FS
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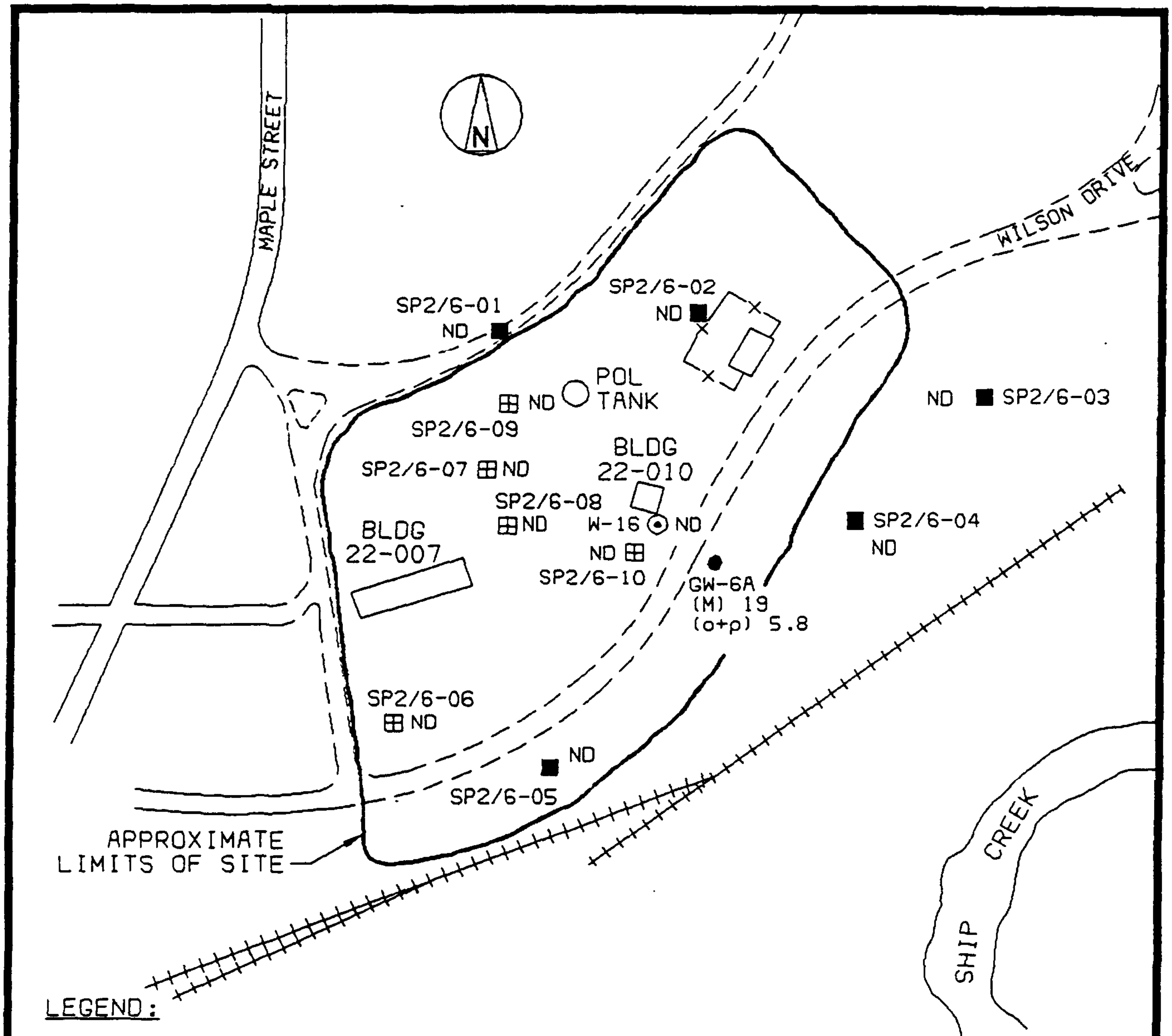
Figure
4.2.11.7



LEGEND:

SP2/6-09	STAGE 3 BOREHOLE
W-14	MONITORING WELL LOCATION, PHASE II, STAGE 1
GW-4A	MONITORING WELL LOCATION, PHASE II, STAGE 2
SP4/11-03	MONITORING WELL LOCATION, STAGE 3
	RAILROAD

BORING/WELL NUMBER
BORING/WELL LOCATION
DEPTH OF SAMPLE (ft)
ANALYTE CONCENTRATION

SOIL: mg/kg
WATER: mg/L
ND: NON-DETECTED

(SYMBOL)
10/300
SP2/6-01

NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

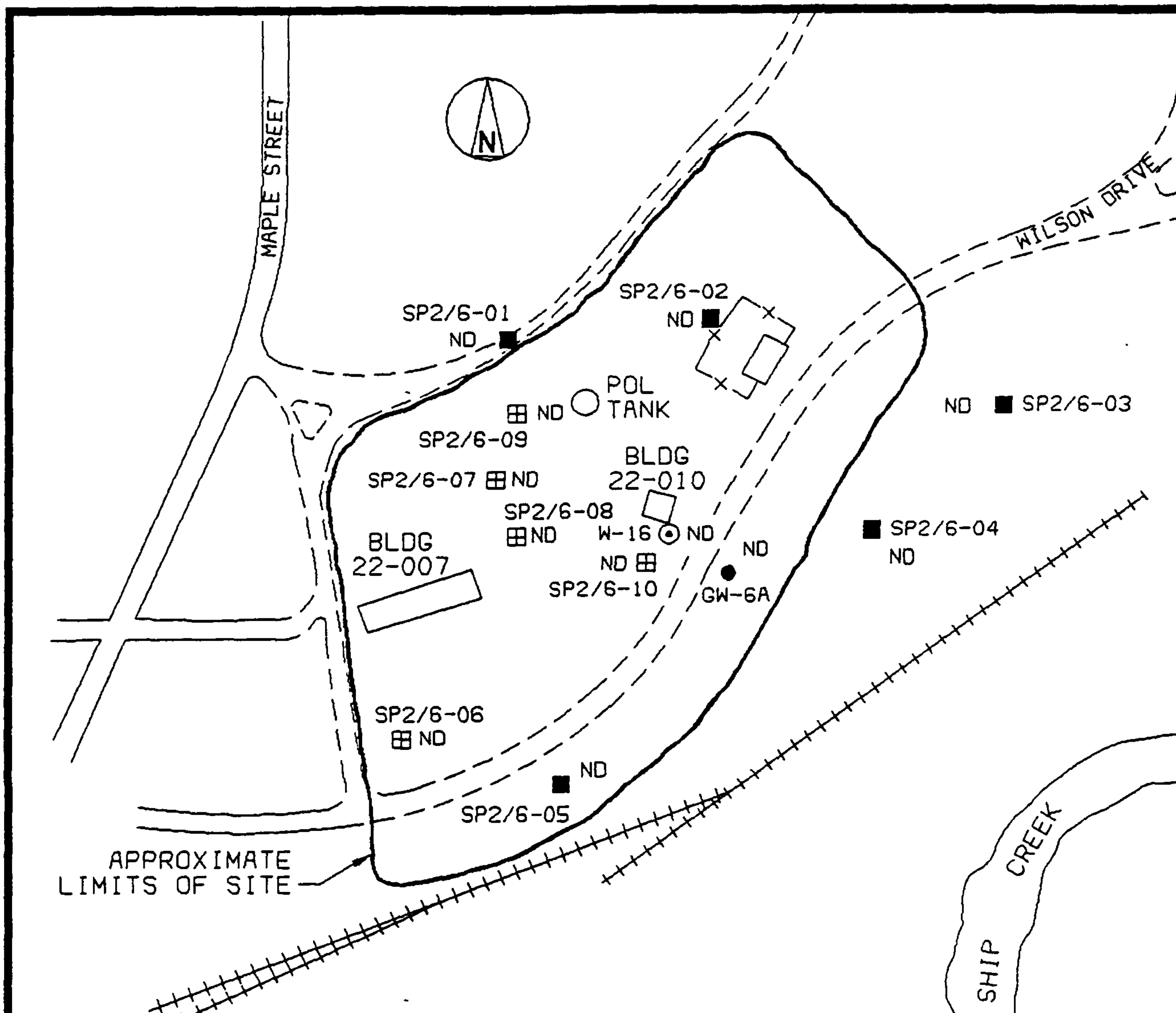
0 200 400ft

SCALE

(m), (o+p) XYLENE CONCEMTRATION SITES SP-2 & SP-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.11.8



LEGEND:

⊞ SP2/6-09	STAGE 3 BOREHOLE
⊙ W-14	MONITORING WELL LOCATION, PHASE II, STAGE 1
● GW-4A	MONITORING WELL LOCATION, PHASE II, STAGE 2
■ SP4/11-03	MONITORING WELL LOCATION, STAGE 3
+++++++	RAILROAD

BORING/WELL NUMBER
BORING/WELL LOCATION
DEPTH OF SAMPLE (ft)
ANALYTE CONCENTRATION

SOIL: mg/kg
WATER: mg/L
ND: NON-DETECTED

(SYMBOL)
10/300
SP2/6-01

NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

0 200 400ft
SCALE

2-METHYLNAPHTHALENE
CONCEMTRATION
SITES SP-2 & SP-6

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.11.9

4.2.11.1.4 Analytical Results Table

The laboratory analytical results for detected parameters at Site SP-2/6 are presented on Table 4.2.11.4.

4.2.11.1.5 Discussion of Analytical Data

Volatile organic compounds such as toluene, ethylbenzene, and xylene were detected in samples taken at Site SP-2/6. However, the level of contamination was generally low, and isolated to 1 or 2 wells or boreholes (Figures 4.2.11.6 through 4.2.11.9). For example, a water sample from the previously existing well GW-6A contained toluene (4.5 ug/L), ethylbenzene (30 ug/L), m-xylene (19 ug/L), and o&p-xylene (5.8 ug/L). These compounds were not found in any other samples collected from the site. The compound 2-methylnaphthalene was detected at a concentration of 17 mg/kg in a soil sample taken at a depth of 30 feet from borehole SP2/6-10. The most pervasive contaminant was petroleum hydrocarbons detected in 4 water samples and 2 soil samples from the southern portion of the site. Total petroleum hydrocarbon concentration in the water samples from wells SP2/6-03, SP2/6-04 and SP2/6-05 were 3.3, 1.0 and 5.8 mg/L, respectively. Total petroleum hydrocarbon content of soils from a depth of 30 feet in boring SP2/6-10 and from 35 feet deep in boring SP2/6-04 were 9840 and 1760 mg/kg, respectively.

4.2.11.2 Sampling or Analytical Problems

Sampling or analytical problems including loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan that may have occurred at Site SP-2/6 are addressed below.

Table 4.2.11.4

Analytical Results - Site SP-2/6

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-16 GN840266	W-16-8 35' W-16	W-16 40' W-16-9	W-16 W-16/25	W-16 W-16/26	GW-6A GW-6A/27	GW-6A GW-6A/28	GW-6A(fqc) GW-6A/31
MOISTURE	GRAV.	%			11	39					
OIL & GREASE	413.2	mg/L		8.6	28						
TDS	160.1	mg/L	500				320		320		
TOC	415.1	mg/L		1							
Total Petroleum Hydrocarbons	418.1							0.8		61	12

Table 4.2.11.4

Analytical Results - Site SP-2/6

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP2/6-01 40'-41.5' 0687-SO-051 GS-88-0001 000847-0001	SP2/6-02 30'-31.5' 0687-SO-052 GS-88-0001 000889-0003	SP2/6-09 50'-51.5' 0687-SO-059 GS-88-0001 000975-0003	SP2/6-07 40'-41.5' 0687-SO-057 GS-88-0001 000889-0001	SP2/6-03 0687-NG-053 GN-88-0002 001229-0011	SP2/6-03 DUPLICATE 0687-NG-053 GN-88-0002D 001229-0011
2-Methylnaphthalene	Method 8270	mg/kg							
Ethyl benzene	EPA 602	ug/L	700						
Toluene	EPA 602	ug/L	2,000						
Total Dissolved Solids	160.1	mg/L	500						
Total Petroleum Hydrocarbons	EPA 418.1							3.3	3.5
Total Solids	160.3	%		79.5	91.4	82.1	89.8		
m-Xylene	EPA 602	ug/L	440						
o & p-Xylene(s)	EPA 602	ug/L	440						

Table 4.2.11.4

Analytical Results - Site SP-2/6

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP2/6-03 45'-46.5' 0687-SO-053 GS-88-01 000960-0003	SP2/6-08 50'-51.5' 0687-SO-058 GS-88-01 000960-0001	SP2/6-10 30'-31.5' 0687-SO-060 GS-88-01 000960-0002	GW-6A 0687-NG-062,GW-88-0001 001206-0009	SP2/6-06 50'-51.5' 0687-SO-056,GS-88-0001 001017-0008	SP2/6-04 0687-NG-054 GW-88-0002 001229-0005
2-Methylnaphthalene	Method 8270	mg/kg				17			
Ethyl benzene	EPA 602	ug/L	700				30.		
Toluene	EPA 602	ug/L	2,000				4.5		
Total Dissolved Solids	160.1	mg/L	500						
Total Petroleum Hydrocarbons	EPA 418.1					9843	64.		1.0
Total Solids	160.3	%		82.0	87.1	89.1		90.0	
m-Xylene	EPA 602	ug/L	440				19.		
o & p-Xylene(s)	EPA 602	ug/L	440				5.8		

Table 4.2.11.4

Analytical Results - Site SP-2/6

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP2/6-04 35'-36.5' 0687-SO-054,GS-88-0001 001017-0006	SP2/6-05 0687-NG-055,GN-88-0003 001278-0001	SP2/6-05 30'-31.5' 0687-SO-055,GS-88-0001 001017-0007
2-Methylnaphthalene	Method 8270	mg/kg				
Ethyl benzene	EPA 602	ug/L	700			
Toluene	EPA 602	ug/L	2,000			
Total Dissolved Solids	160.1	mg/L	500			
Total Petroleum Hydrocarbons	EPA 418.1			1763	5.8	
Total Solids	160.3	%		82.8		93.7
m-Xylene	EPA 602	ug/L	440			
o & p-Xylene(s)	EPA 602	ug/L	440			

4.2.11.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis were lost from Site SP-2/6.

4.2.11.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds usually associated with laboratory contamination were detected in soil or water samples from the site.

4.2.11.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Ten soil samples were collected from 10 test borings at Site SP-2/6. Five of the borings were completed as monitoring wells and 1 water sample was collected from each well. In addition, 2 existing wells at the site were sampled. No out-of-control conditions occurred during drilling or water sampling operations.

4.2.11.3 Significance of Findings

Total petroleum hydrocarbons and other organic compounds were detected in some of the soil and water samples from Site SP-2/6. Water samples from wells SP2/6-02, SP2/6-03, SP2/6-05, and GW-6A had petroleum odors and sheen, thereby exceeding State of Alaska Drinking Water Standards. Water samples collected in 1986 from well W-16 and

GW-6A contained total petroleum hydrocarbons at levels of 6.3 and 6.0 mg/L, respectively (Dames and Moore, 1987). A 1988 sample from well W-16 was not contaminated above detection limits.

TPH was detected in soils at concentrations (9840 mg/kg maximum) which exceed the Alaska Interim Soil and Groundwater Cleanup Guidelines. Petroleum odors were also detected during drilling of wells SP2/6-01 and SP2/6-05 and boreholes SP2/6-08 and SP2/6-10. An HNu meter also detected organic vapors during drilling of wells SP2/6-01, SP2/6-02, SP2/6-04 and SP2/6-05, and boreholes SP2/6-06, SP2/6-07, SP2/6-08 and SP2/6-10.

The source of petroleum hydrocarbons and associated volatile organics in the soil and water at this site is probably a combination of a JP-4 leak from an underground pipeline and a diesel fuel spill. Eight thousand gallons of diesel were reported spilled, and the amount of JP-4 lost due to leakage is unknown (Engineering Science, 1983).

Pathways of exposure are contact with and ingestion or uptake of contaminated ground or surface water. Contact with surface soils contaminated with petroleum hydrocarbons constitutes an additional pathway. Receptors of the contamination are humans, wildlife, fish and plants.

4.2.11.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. A soil gas survey at Site SP-2/6 showed detectable BTX and unidentified organic contamination throughout the site (Figure 4.2.11.4). However, no areas of contamination exceeding 10 ppm BTX were detected. Laboratory analyses of the water samples from wells SP2/6-03, SP2/6-04, and SP2/6-05, all of which are south of Wilson Drive, contained petroleum hydrocarbons. Petroleum hydrocarbons were detected in soil samples collected from a depth of

35 feet from well SP2/6-04 and from 30 feet deep in boring SP2/6-10. No contamination of the soil or water was detected in samples from the remaining boreholes and wells located north of Wilson Drive. General concentration lines have been constructed for the soil gas data, but there is insufficient data from other sources to allow three-dimensional temporal or higher-definition spatial mapping.

4.2.11.3.2 Contaminant Migration

Petroleum hydrocarbons are probably migrating in the groundwater as evidenced by contamination detected in water samples from the down-gradient wells (wells SP2/6-03, SP2/6-04, SP2/6-05 and GW-6A). Boreholes SP2/6-06, SP2/6-07, SP2/6-08 and SP2/6-09 are located upgradient of well SP2/6-05, but soil samples collected at or below the water table in these boreholes did not contain petroleum hydrocarbons at levels above the method detection limits. A soil sample collected at the water table from borehole SP2/6-10, upgradient from wells SP2/6-04 and GW-6A, was contaminated with 9840 mg/kg of total petroleum hydrocarbons. The JP-4 leak location has not been clearly identified, but past reports indicate that the diesel spill of 1976 occurred during fuel transfer at the aboveground POL tank (Phase I Records Search, Engineering Science 1983). Boreholes immediately downgradient of the tank were not found to be contaminated, but the wells located further downgradient are contaminated with petroleum hydrocarbons. Contamination by petroleum hydrocarbons detected in 1986 in well W-16 was not found in 1988. However recent samples from well GW-6A, further downgradient of the site, were more contaminated. These findings suggest that there may be a contamination plume and that it is migrating downgradient.

4.2.11.3.2.1 Potential for Offsite and Off-Base Migration

Offsite migration of contamination has been determined to be occurring at Site SP-2/6. The plume boundaries have not been clearly defined,

but the 4 contaminated wells are located near the probable downgradient boundary of Site SP-2/6. The actual spill or leak locations have not been identified, but are presumed to have occurred further to the north near a POL tank or a gasoline fill-stand at building 22-010.

The soil gas survey detected contamination encompassing about 11 acres, covering areas to the north, south, east and west of the presumed spill and leak sites. The survey did not extend offsite.

4.2.11.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site at the time of the investigation indicated the direction of groundwater flow is to the south and southeast with a gradient of about 130 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g, water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of the migration rate of the dissolved chemicals.

4.2.11.3.2.3 Time of Travel to Receptors

The primary receptors are humans, wildlife, fish and plants. Primary pathways are ingestion of contaminated ground and surface water. A secondary exposure route would be the ingestion of contaminated plants or fish. Ship Creek is located less than 600 feet southwest of Site SP-2/6. Hydraulic conductivities have not determined for this site; thus, time of travel to the creek cannot be estimated. Any

contamination reaching the creek is expected to become highly diluted within the creek water. No active drinking water wells are located downgradient of the site.

4.2.11.3.2.4 Applicability of Solute Transport Models

Solute transport models may be important at Site SP-2/6. Wells installed to the south of the site may provide additional hydrogeologic data and allow the formation of more accurate solute transport models based on increased contaminant distribution data. The results of this modeling would help to determine the potential risk for downgradient water supplies and surface water.

4.2.11.3.2.5 Expected Spatial and Temporal Variations in Concentration

Contamination by petroleum hydrocarbons was detected in 2 soil samples collected at the site; these samples were collected from depths of 30 and 35 feet.

A soil gas survey detected contamination by BTX and unidentified organic contamination encompassing an area of about 11 acres. The actual spill site is not known, but it can be assumed that some of this contamination is upgradient of the spill.

The spatial extent of contamination in groundwater reaches across Wilson Road to wells SP2/6-03, SP2/6-04, SP2/6-05 and GW-6A. The most downgradient of these wells is SP2/6-05.

All of the wells are presumed to be located within the site boundaries. The 2 upgradient wells, wells SP2/6-01 and SP2/6-02, did not contain contamination above method detection limits.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of the contaminants is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.11.3.3 Baseline Risk Assessment

The contamination in relation to exposure routes, receptors, and health effects are evaluated in the following sections.

4.2.11.3.3.1 Waste Characterization

The primary wastes at the site are petroleum hydrocarbons and volatile organics. Total petroleum hydrocarbons were detected in soil and water samples at Site SP-2/6. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects. Toluene and ethylbenzene were detected in 1 water sample from the site. These volatile organics also are toxic, but were detected below the proposed MCLs of 2000 and 700 ug/L, respectively.

4.2.11.3.3.2 Source and Release Characterization

Petroleum hydrocarbons were released to the environment as the result of a pipeline leak of JP-4 and a spill of diesel fuel. Eight thousand gallons of diesel were reported spilled. The amount of JP-4 leaked was never recorded. It is not known if any recovery activities for fuels occurred or were successful for the JP-4 leak. The diesel spill occurred in the winter and most of the fuel was recovered (Engineering-Science, 1983).

4.2.11.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons and volatile organics released to the environment at Site SP-2/6 includes long-term natural degradation, dispersion of the contaminants through runoff, or uptake by living organisms. Another possible fate is the volatilization of fractions that have vapor pressures greater than 1 mm of mercury.

Dissolved contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration with the groundwater through the process of advection. Additional transport can occur in the form of surface runoff or release of vapor to the atmosphere. Contaminated soil or water from the site can be transported through human intervention.

4.2.11.3.3.4 Exposure Pathways

The exposure pathway for humans, fish and wildlife is contact with or ingestion of contaminated ground or surface water, fish, or plants.

4.2.11.3.3.5 Identification of Receptors

Receptors are humans, fish, wildlife and plants. Human receptors include anyone ingesting water or fish from Ship Creek. Larger plants in the area of this well may also become contaminated since groundwater is located at a depth of 30 to 35 feet.

4.2.11.3.3.6 Threat to Human Health

A possible threat to human health exists from the drinking of Ship Creek water, or the ingestion of fish from Ship Creek. The threat to human health from exposure to Ship Creek water and/or fish is unknown, but is expected to be low due to the low toxicity of contaminants detected at the site, and the high rate of dilution expected in creek water.

4.2.11.3.3.7 Carcinogenic Risks

No carcinogenic compounds were detected in water and soil samples collected from Site SP-2/6.

4.2.11.3.3.8 Threat to Wildlife

Threat to wildlife is possible through ingestion of contaminated surface water. Ship Creek constitutes the nearest surface water body. Ship Creek waters directly downgradient of the site have not been sampled. The threat of this water to wildlife is unknown, but is expected to be low due to the low toxicity of contaminants detected at Site SP-2/6 and the high dilution rate expected in creek water.

4.2.11.4 Prioritization of Sites for Remedial Alternatives

Site SP-2/6 is recommended for medium priority status due to the concentrations of petroleum hydrocarbons in water samples from this site and the proximity to Ship Creek. The installation of 3 new monitoring wells is required at this site. The wells should be situated downgradient, between the toe of the bluff and the railroad tracks, if there is sufficient space. A soil gas survey and use of field screening probes would be useful in plume delineation between the site and Ship Creek and selection of locations for the proposed

monitoring wells. Additional sampling of the 5 existing wells is needed. Water shall be sampled seasonally from the wells and shall be analyzed for total petroleum hydrocarbons, purgeable aromatics and purgeable halocarbons. In addition, the water of Ship Creek at a point immediately downgradient of the site should be sampled and analyzed for total petroleum hydrocarbons, purgeable aromatics and purgeable halocarbons. The result of these tests may aid in identifying the dilution, diffusion, and dispersion characteristics at the site.

4.2.12 Discussion of Results for Site SP-4, Railroad Maintenance Area Oil Spill

During the late 1960's oil globules were seen seeping out of the bank near the railroad maintenance facility and collecting in a marshy area south of the building (Figure 4.2.12.1). The source of the oil was presumed a result of maintenance activities at the railroad facility. It is expected that some of this oily material sank into the marsh. (Engineering-Science, 1983)

4.1.12.1 Presentation of Results for Site SP-4

Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site maps.

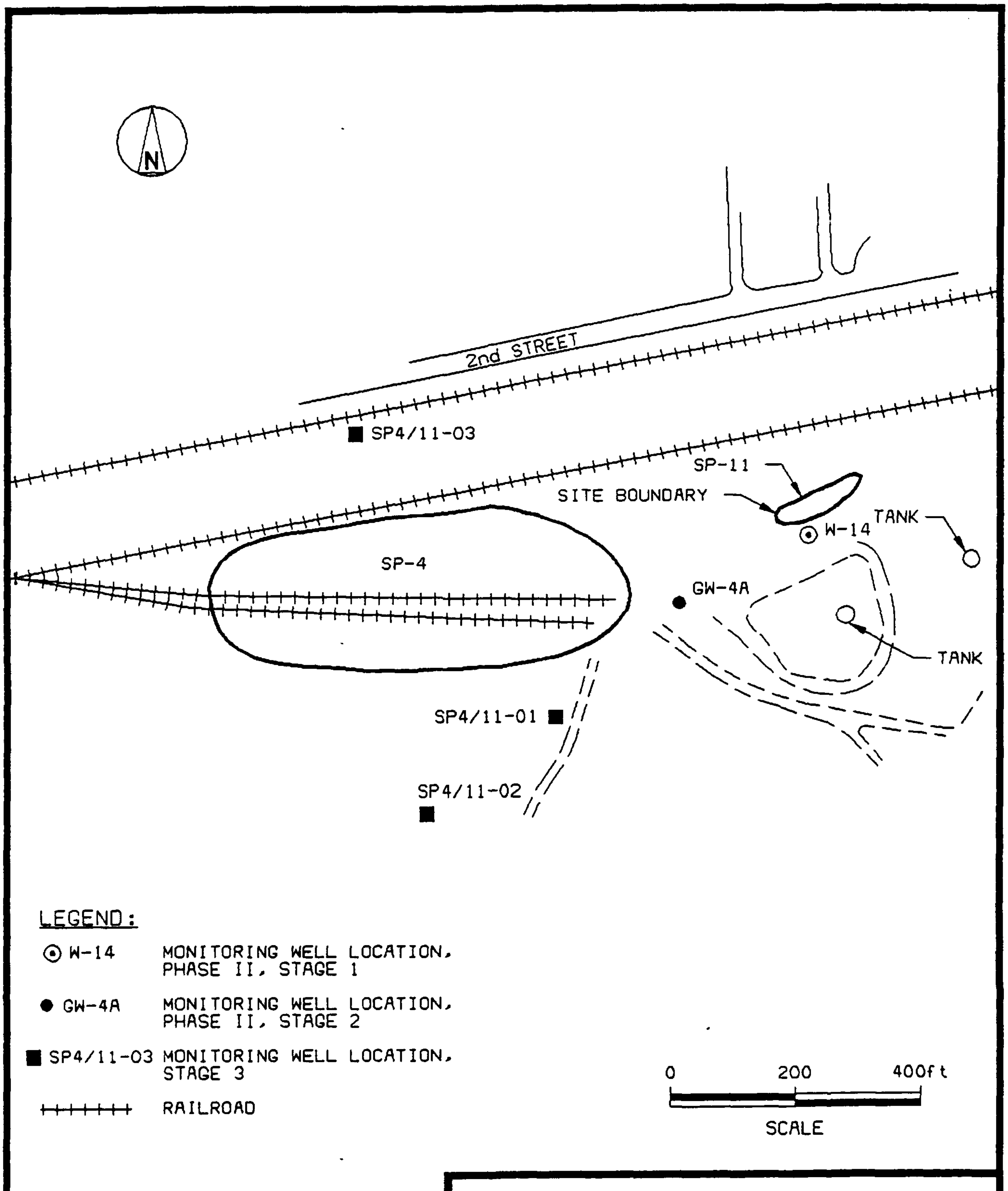
4.2.12.1.1 Site Geology

Site SP-4 is located in a flat area of an abandoned Ship Creek floodplain at an elevation of 130 to 175 feet. The site is situated at the base of a bluff and was partially flooded by water backed up by dams recently constructed by beavers. The site is underlain by sands and gravels. The site is vegetated with dense cottonwood trees to 25 feet in height with scattered spruce and birch.

Three borings were drilled at the site. Boring logs are presented in Appendix C. An interpreted gamma log of well SP4-01 is presented in Appendix D. A schematic geologic cross section of the site is presented in Figure 4.2.12.2.

4.2.12.1.2 Site Hydrogeology

Site SP-4 is underlain by sands with some silts and gravels. Water table depths range from approximately 1 to 35 feet. The direction of

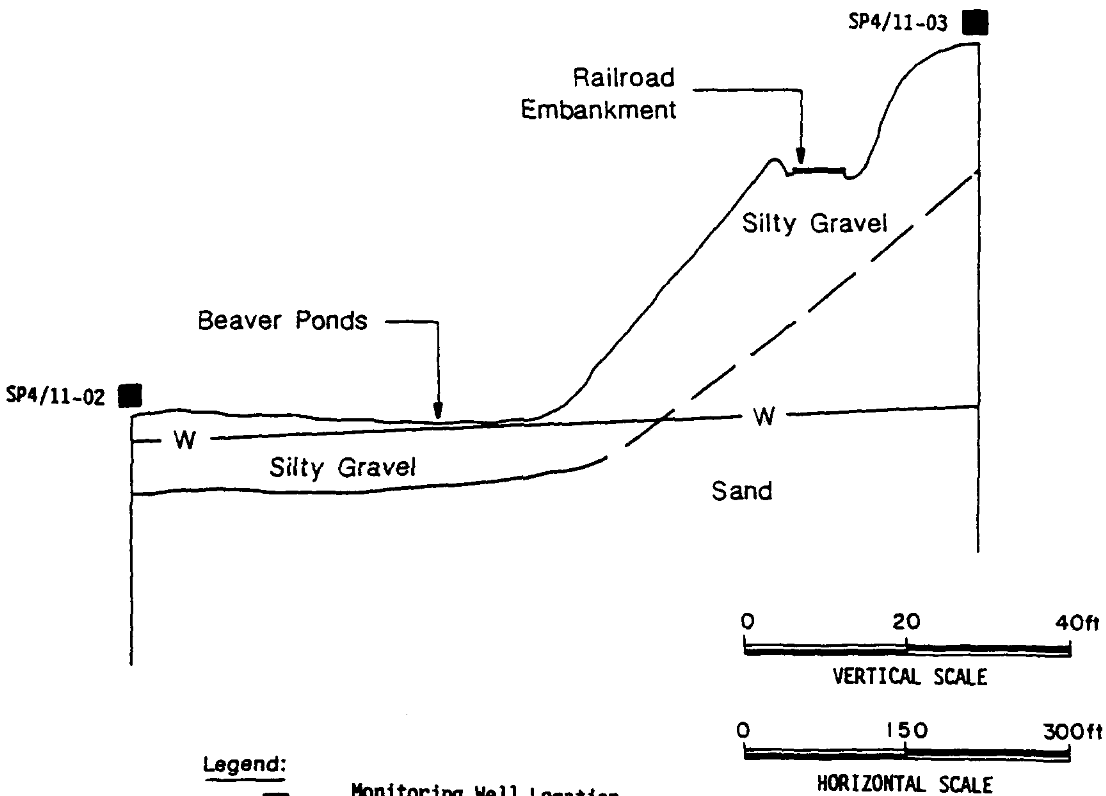


LOCATION MAP

SITE SP-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.12.1



Legend:

SP4/11-03 ■ Monitoring Well Location Stage 3

—— W —— Projected Water Table

—— — — Geologic Contact, Dashed Where Inferred

Notes:

1. Horizontal scale: 1 inch = 150 feet.
2. Vertical scale: 1 inch = 20 feet.
3. Geologic cross section location shown on Figure 4.2.12.3

GEOLOGIC CROSS SECTION
SITE SP-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.12.2

groundwater flow is based on a comparison of regional trends and water-level measurements at 9 wells in the area (Figure 4.2.12.3). The groundwater flow direction is south-southwest with a gradient of approximately 60 feet per mile. Hydraulic conductivities values have not yet been established for this site.

4.2.12.1.3 Analytical Results

Field analytical results and observations and laboratory results are discussed in the following sections.

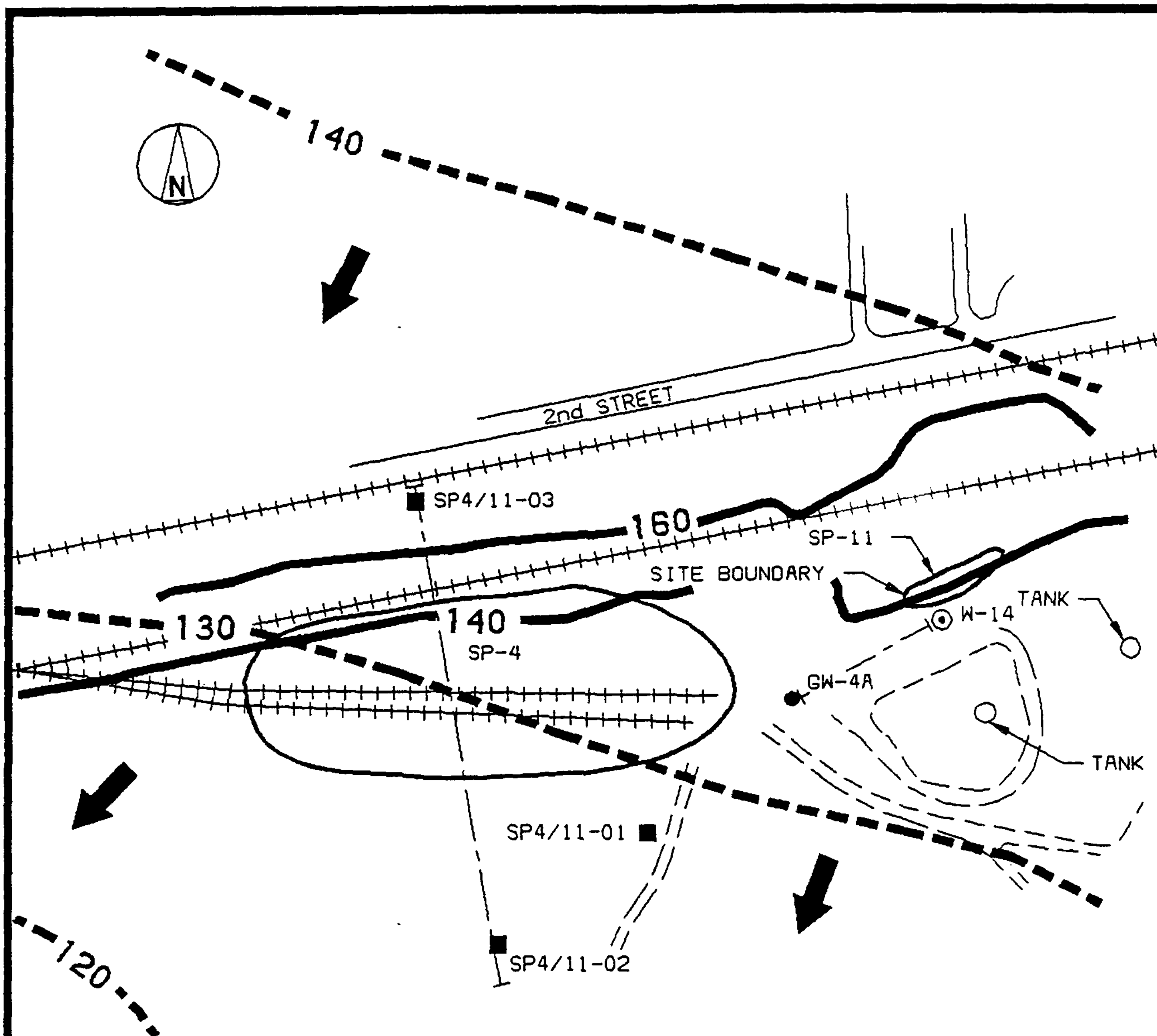
4.2.12.1.3.1 Field Analytical Results and Observations

Results of a soil gas survey conducted at Site SP-4 are presented on Figure 4.2.12.4 and in Table 4.2.12.1. Isoconcentration contours have been drawn based on the findings of the field analysis. Evidence of contamination based on visual observations, HNu readings, and odor at subsurface investigation sites was recorded during the field investigation program.

The following evidence of contamination was observed:

- o Well SP4-01 - An HNu reading of 0.5 ppm was recorded on a soil sample taken at a depth of 5 feet.
- o Well SP4-03 - The following HNu readings were recorded on soil samples:

Depth of Sample	HNU Reading
2 feet	200 ppm (odor) on cuttings
5 feet	20 ppm (odor)
10 feet	40 ppm (odor)
15 feet	50 ppm (odor)
20 feet	20 ppm (odor)
25 feet	7 ppm (odor)
30 feet	4 ppm (odor)



LEGEND:

W-14 MONITORING WELL LOCATION, PHASE II, STAGE 1

GW-4A MONITORING WELL LOCATION, PHASE II, STAGE 2

SP4/11-03 MONITORING WELL LOCATION, STAGE 3

RAILROAD

APPROXIMATE DIRECTION OF GROUNDWATER FLOW

120 WATER TABLE CONTOUR, 10' INTERVALS

300 LANDSURFACE CONTOUR, 20' INTERVAL

GEOLOGIC CROSS SECTION

0 200 400ft

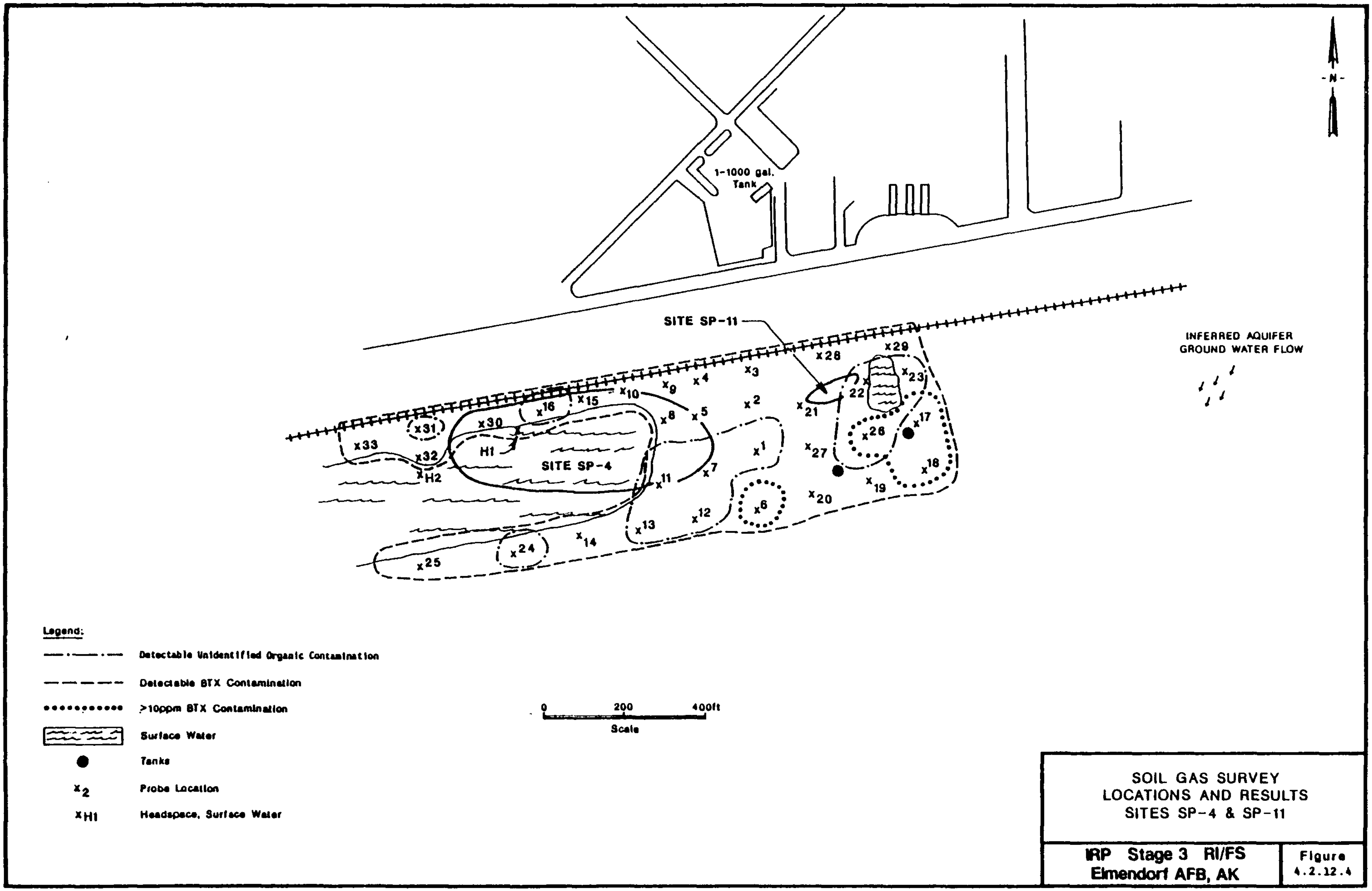
SCALE

HYDROGEOLOGIC MAP

SITE SP-4

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.12.3



SOIL GAS SURVEY
LOCATIONS AND RESULTS
SITES SP-4 & SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.12.4

Table 4.2.12.1 Summary of Gas Chromatograph Analyses of Soil Gas Samples from Sites SP-4 and SP-11.

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified organics (ppm)	Comments
1	10	-	1.36	.58	.09	Unidentified organics at 1.1 RT
2	10	-	.39	.03	-	
3	5	-	1.54	TR	.29	
	10	-	1.46	TR	-	
4	5	-	.68	.40	.16	
	10	-	.01	-	-	
5	10	TR	1.17	.03	TR	
6	5	6.15	TR	15.97	-	Water to surface; diesel; possibly with JP4
7	5	-	1.27	8.43	-	
	10	-	1.19	1.59	.42	
8	5	-	1.33	-	-	
	10	-	1.95	-	-	
9	8.5	-	.63	-	-	
10	8.5	-	.80	.19	.17	
11	5	-	.79	9.53	.65	
12	5	-	1.70	2.57	.11	
	10	.13	.79	.77	.20	
13	5	-	1.17	1.08	.53	
14	10	-	4.14	8.89	-	
15	6.5	-	1.76	-	-	
16	10	-	1.02	.82	.45	
17	10	-	1.67	9.80	-	
18	10	-	19	-	-	
19	10	-	-	1.41	TR	
20	10	-	.22	.35	-	
21	10	-	1.58	-	-	
22	10	-	2.99	-	.44	
23	10	-	1.42	TR	.16	
24	10	-	1.62	3.49	.09	
25	10	.34	2.27	.40	-	
26	10	-	2.85	8.89	.12	
27	10	-	1.90	2.9	-	
28	8	-	TR	TR	-	
29	10	-	.09	-	TR	
30	10	TR	.22	TR	TR	
31	10	-	TR	-	.94	
32	10	2.27	1613	-	-	Diesel; possibly with JP4
33	10	-	TR	5.63	-	
H1 headspace		-	2.46	-	-	Water sample with visible sheen
H2 headspace		-	.786	-	-	

Note: Unidentified organics are reported in benzene equivalent ppm.
TR - Trace
RT - Retention Time

Field parameters measured at Site SP-4 during groundwater sampling are included in Table 4.2.12.2.

4.2.12.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site SP-4 is presented in Table 4.2.12.3, and the sample plan for the base-wide field investigation program is included in Appendix B. Major organic contaminants

Table 4.2.12.2 Field Parameters Site SP-4

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
SP4-01	8/12/88	9.5	292	7.10	188	No odor or sheen
SP4-02	8/16/88	7.8	255	7.29	220	No odor or sheen
SP4-3	8/29/88	6.5	340	5.30	268	Sl POL odor, sheen

Table 4.2.12.3 Requested Analyses for Laboratory Samples at Site SP-4

SOIL/SEDIMENT

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
6010	ICP Screen (25 metals)
7471	Mercury
8080	Organochlorine Pesticides and PCBs
8240	Volatile Organic Compounds
8270	Semi-volatile Organic Compounds
160.3	Soil Moisture Content

WATER

Test Number	Analysis
418.1	Petroleum Hydrocarbons
602	Purgeable Aromatics
625	Extractable Priority Pollutants

identified from the laboratory analysis of samples collected at Site SP-4 are plotted on Figures 4.2.12.5 through 4.2.12.8. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well or test boring. Sampling depth is included for the soil samples. Results of analytical tests are presented in Table 4.2.12.4.

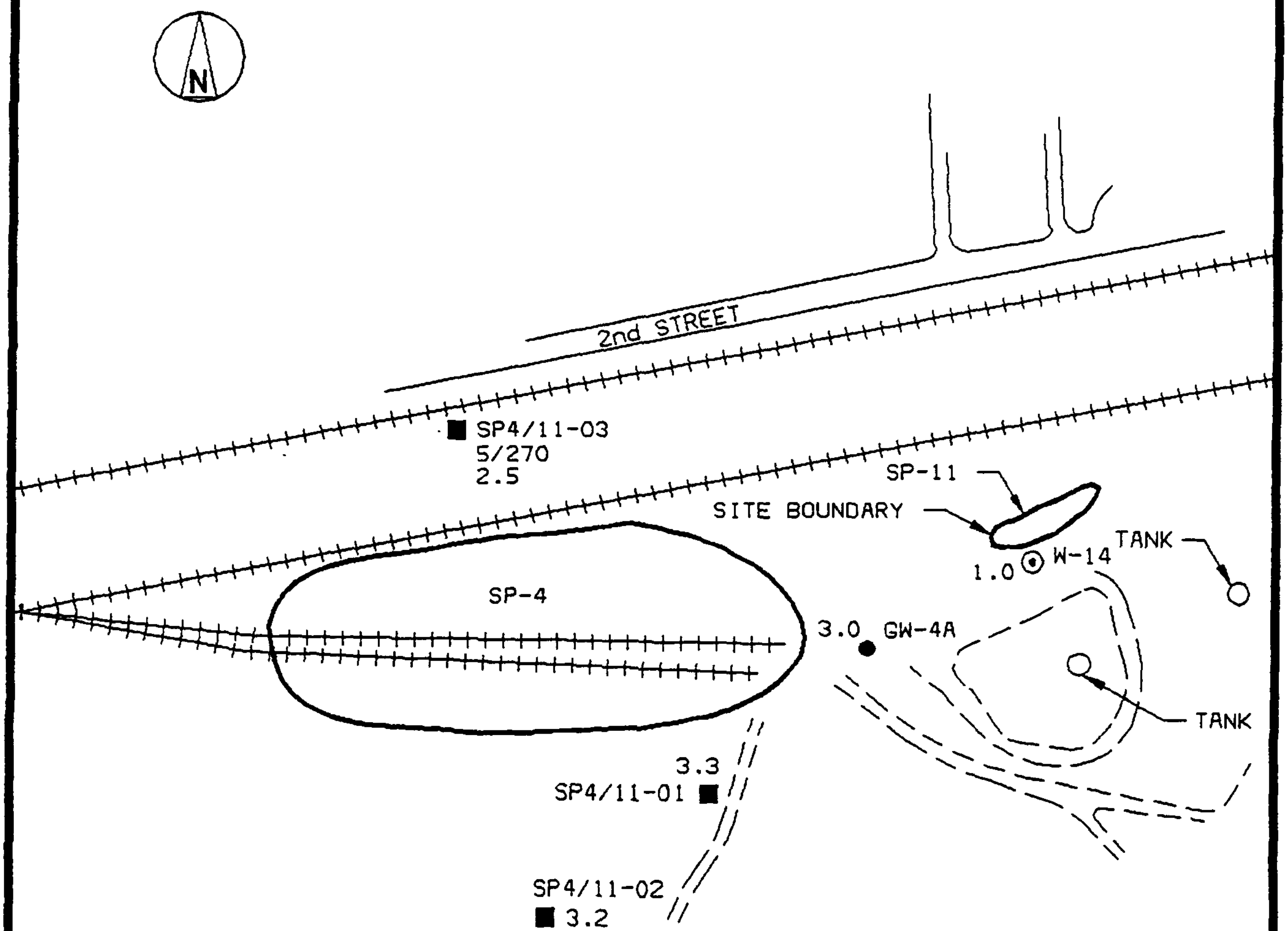
4.2.12.1.4 Analytical Results Table

All of the laboratory analytical results for Site SP-4 are presented on Table 4.2.12.4.

4.2.12.1.5 Discussion of Analytical Data

A total petroleum hydrocarbon concentration of 3.3, 3.2, and 2.5 mg/L was detected from wells SP4-01, SP4-02, and SP4-03, respectively. Total petroleum hydrocarbons were detected in the soil sample taken at a depth of 5 feet from boring SP4-03 at a concentration of 270 mg/kg. Volatile organic compounds were detected in samples from Site SP-4. However, the concentrations were generally low and isolated to 1 or 2 borings. For example, benzene was detected in a water sample from well SP4-01 at a concentration of 27 ug/L. Toluene was detected in water samples from both wells SP4-01 and SP4-03 at concentrations of 1.1 and 6.5 ug/L, respectively. The water sample from well SP4-03 also contained ethyl benzene at a concentration of 3.0 ug/L.

Metals such as aluminum (9800 to 14500 mg/kg), iron (19400 to 26500 mg/kg), manganese (370 to 650 mg/kg) and magnesium (6600 to 10100 mg/kg) were detected in soil samples from the site at levels similar to the basewide hydrogeology (background) wells. The levels are related to natural mineral content of the local soils. Water samples from Site SP-4 were not tested for these metals.



LEGEND:

⊙ W-14	MONITORING WELL LOCATION, PHASE II, STAGE 1
● GW-4A	MONITORING WELL LOCATION, PHASE II, STAGE 2
■ SP4/11-03	MONITORING WELL LOCATION, STAGE 3
┼┼┼┼┼┼┼	RAILROAD

(SYMBOL)
WELL NUMBER
WELL LOCATION
DEPTH OF SAMPLE
ANALYTE CONCENTRATION
SOIL: mg/kg
WATER: mg/L
ND: NON-DETECTED
10/300
SP4/11-03

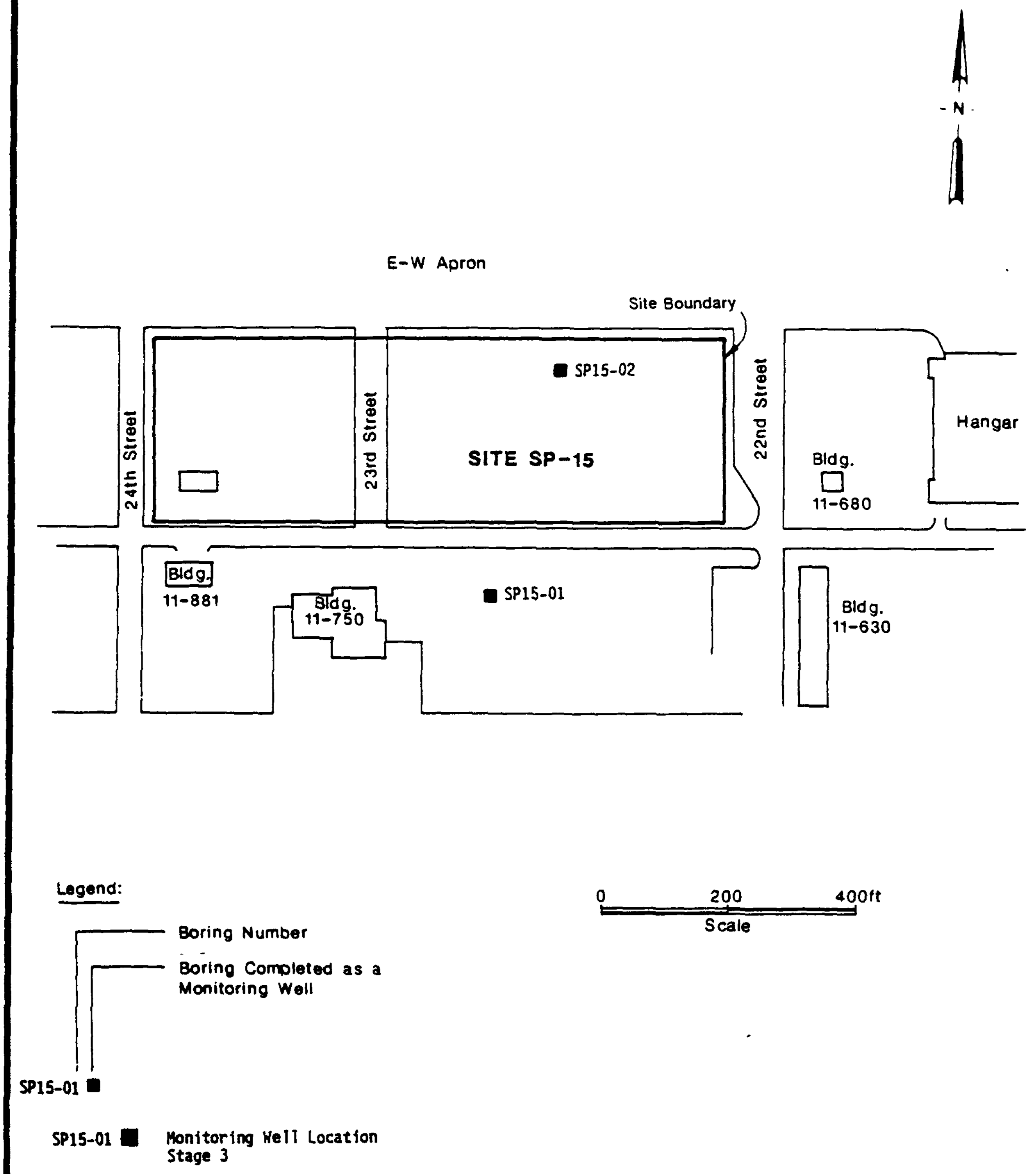
NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

0 200 400ft
SCALE

TOTAL PETROLEUM HYDROCARBON CONCENTRATION
SITES SP-4 & SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

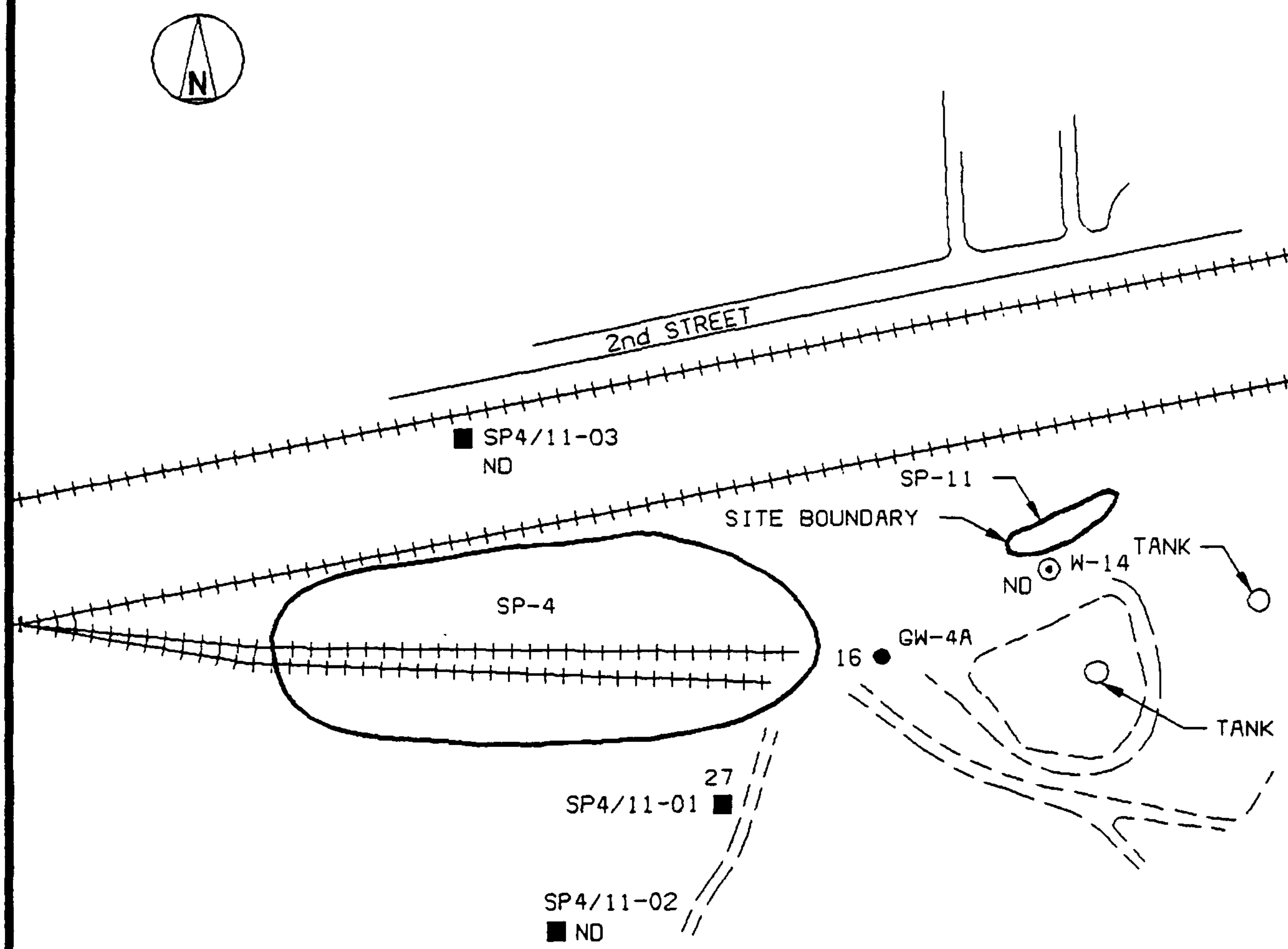
Figure 4.2.12.5



LOCATION MAP
SITE SP-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.18.1



LEGEND:

W-14	MONITORING WELL LOCATION, PHASE II, STAGE 1
GW-4A	MONITORING WELL LOCATION, PHASE II, STAGE 2
SP4/11-03	MONITORING WELL LOCATION, STAGE 3
	RAILROAD

WELL NUMBER
WELL LOCATION
DEPTH OF SAMPLE
ANALYTE CONCENTRATION

SOIL: mg/kg
WATER: mg/L
ND: NON-DETECTED

(SYMBOL) 10/300
SP4/11-03

NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

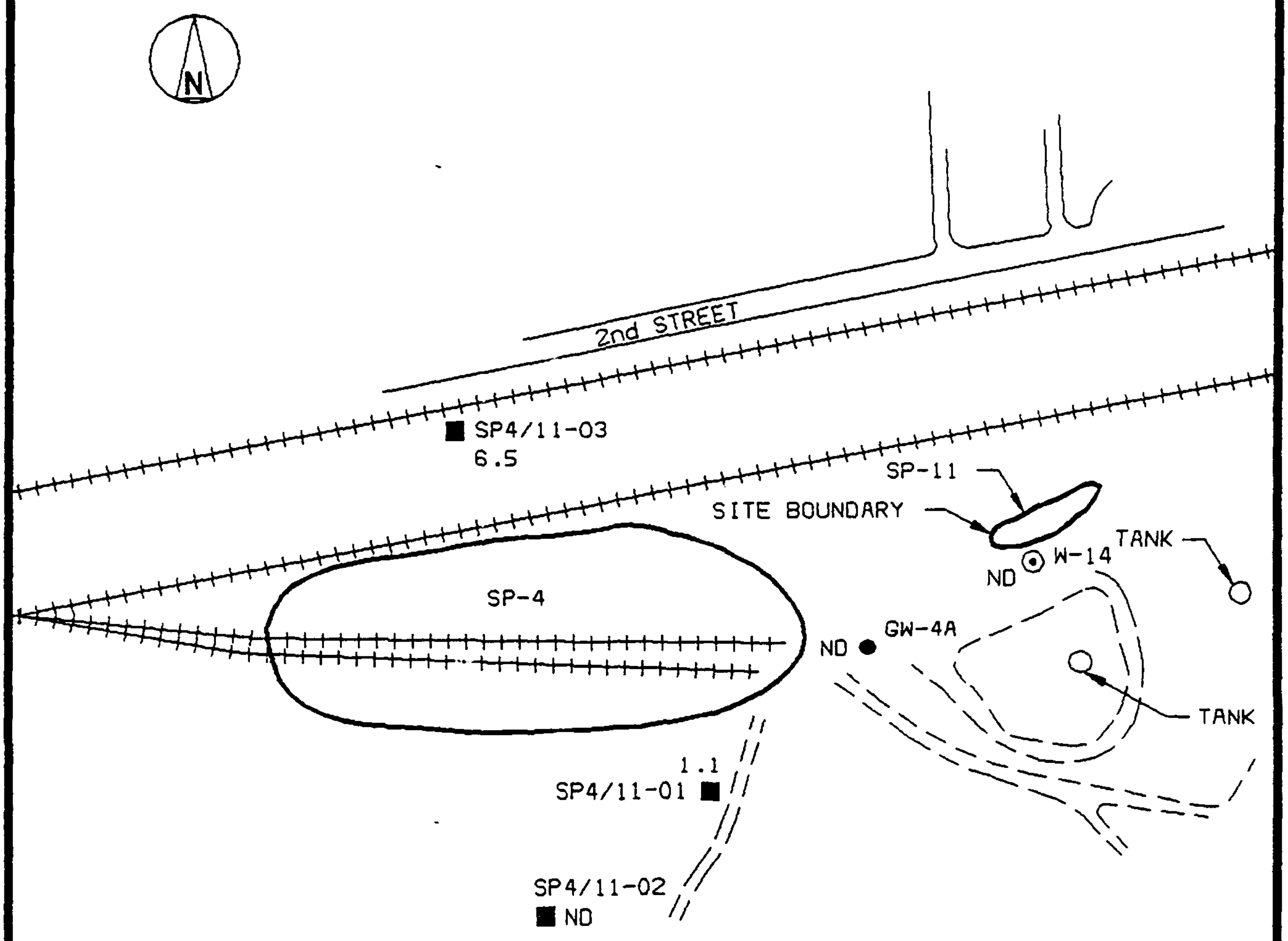
0 200 400ft
SCALE

BENZENE CONCENTRATION

SITES SP-4 & SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.12.6



LEGEND:

- ⊙ W-14 — MONITORING WELL LOCATION, PHASE II, STAGE 1
- ● GW-4A — MONITORING WELL LOCATION, PHASE II, STAGE 2
- ■ SP4/11-03 — MONITORING WELL LOCATION, STAGE 3
- ┼┼┼┼┼┼┼ — RAILROAD

WELL NUMBER
WELL LOCATION
DEPTH OF SAMPLE
ANALYTE CONCENTRATION
SOIL: mg/kg
WATER: mg/L
ND: NON-DETECTED
(SYMBOL)
10/300
SP4/11-03

NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

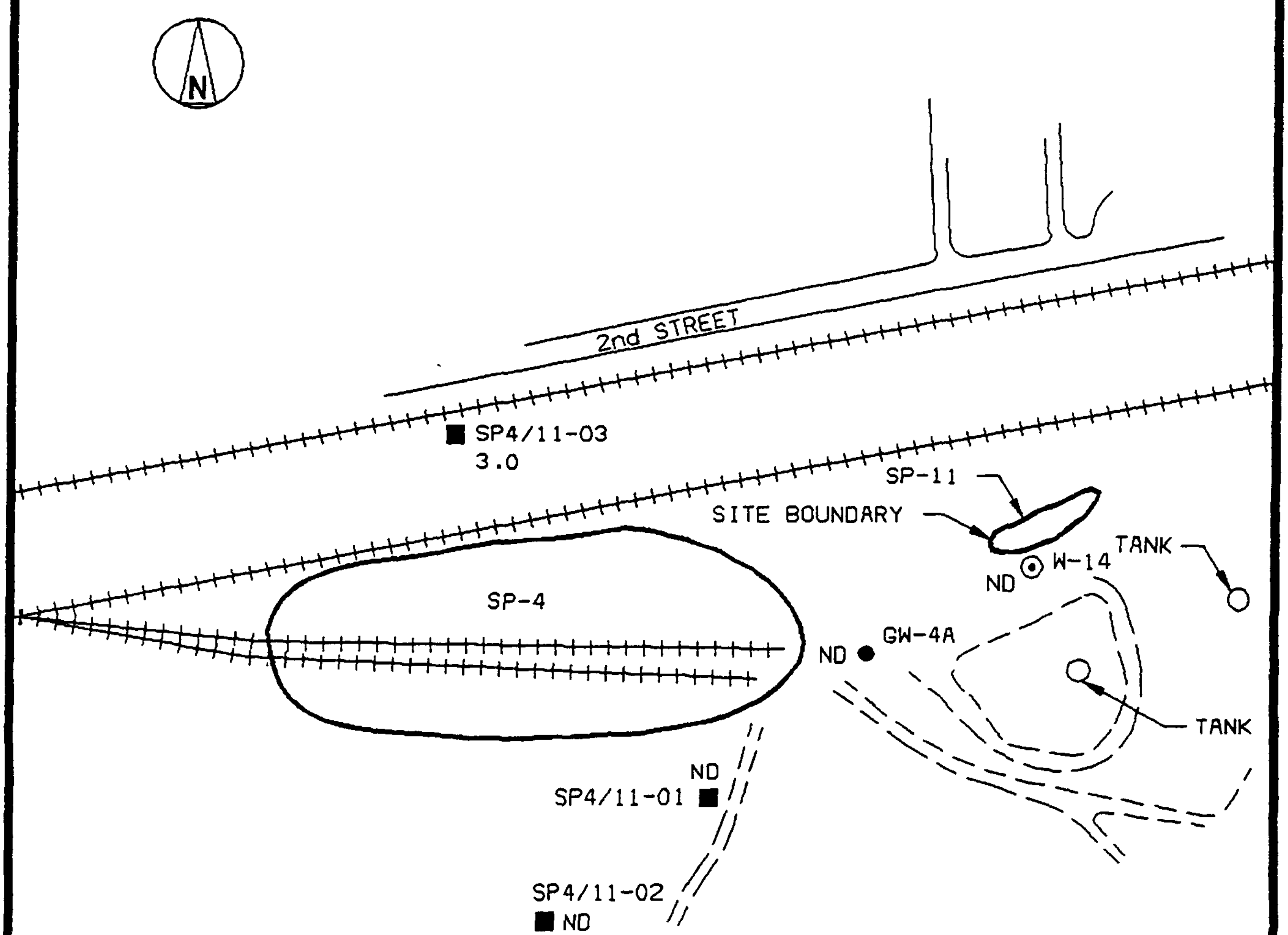
0 200 400ft
SCALE

TOLUENE CONCENTRATION

SITES SP-4 & SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.12.7



LEGEND:

- ⊙ W-14 MONITORING WELL LOCATION, PHASE II, STAGE 1
- ● GW-4A MONITORING WELL LOCATION, PHASE II, STAGE 2
- ■ SP4/11-03 MONITORING WELL LOCATION, STAGE 3
- ┼┼┼┼┼┼┼ RAILROAD

WELL NUMBER
WELL LOCATION
DEPTH OF SAMPLE
ANALYTE CONCENTRATION

SOIL: mg/kg
WATER: mg/L
ND: NON-DETECTED

(SYMBOL)
10/300
SP4/11-03

NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

0 200 400ft

SCALE

ETHYL BENZENE CONCENTRATION

SITES SP-4 & SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.12.8

Table 4.2.12.4

Analytical Results - Site SP-4

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP4-03 0687-NG-065GN-88-03 001434-0007	SP4-03 5'-6.5' 0687-SO-065 GS-88-0001 001116-0001	SP4-03 40'-41.5' 0687-SO-065 GS-88-0002 001116-0002	SP4-01 0687-NG-063 GN-88-0003 001229-0014	SP4-01 10'-11.5' 0687-SO-063-GS-88-0001 001075-0005	SP4-01 25'-26.5' 0687-SO-063-GS-88-0002 001075-0006
Aluminum	6010	mg/kg			14479	11034		11388	9789
Barium	6010	mg/kg			45	46		34	28
Benzene	EPA 602	ug/L	5.0				27.		
Beryllium	6010	mg/kg			0.3	0.2			
Calcium	6010	mg/kg			4062.5	4646		4508	4116
Chromium	6010	mg/kg	50,000		25	21		21	18
Cobalt	6010	mg/kg			9	8		8	8
Copper	6010	mg/kg	1,850		25	19		19	17
Ethyl benzene	EPA 602	ug/L	700	3.0					
Iron	6010	mg/kg			26042	20093		21945	19355
Magnesium	6010	mg/kg			9271	8014		8778	6563
Manganese	6010	mg/kg	11,000		583	430		474	367
Mercury	7471	mg/kg	100			0.12			
Nickel	6010	mg/kg			27	23		25	18
Potassium	6010	mg/kg			625				
Sodium	6010	mg/kg			104	128		119	111
Toluene	EPA 602	ug/L	2,000	6.5			1.1		
Total Petroleum Hydrocarbons	EPA 418.1			2.5	271		3.3		
Total Solids	160.3	%			96.0	86.1		84.3	89.9
Vanadium	6010	mg/kg	1,000		52	36		42	34
Zinc	6010	mg/kg	10,500		53	44		43	38

Table 4.2.12.4

Analytical Results - Site SP-4

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP4-02 10'-11.5' 0687-SO-064-GS-88-0001 001075-0007	SP4-02 25'-26.5' 0687-SO-064-GS-88-0002 001075-0008	SP4-02 0687-NG-064,GN-88-0003 001278-0002
Aluminum	6010	mg/kg		12749	11713	
Barium	6010	mg/kg		59	34	
Benzene	EPA 602	ug/L	5.0			
Beryllium	6010	mg/kg		0.2		
Calcium	6010	mg/kg		4324	4912	
Chromium	6010	mg/kg	50,000	30	25	
Cobalt	6010	mg/kg		10	9	
Copper	6010	mg/kg	1,850	22	20	
Ethyl benzene	EPA 602	ug/L	700			
Iron	6010	mg/kg		26497	22418	
Magnesium	6010	mg/kg		8204	10076	
Manganese	6010	mg/kg	11,000	654	466	
Mercury	7471	mg/kg	100			
Nickel	6010	mg/kg		25	31	
Potassium	6010	mg/kg		1109		
Sodium	6010	mg/kg		222	139	
Toluene	EPA 602	ug/L	2,000			
Total Petroleum Hydrocarbons	EPA 418.1					3.2
Total Solids	160.3	%		90.2	79.4	
Vanadium	6010	mg/kg	1,000	47	42	
Zinc	6010	mg/kg	10,500	48	43	

Calcium (4100 to 4600 mg/kg), sodium (100 to 220 mg/kg), and potassium (630 to 1100 mg/kg) levels in soil were also similar to background concentrations. Potassium was detected only in surface soils from wells SP4-02 and SP4-03.

Concentrations of less than 60 mg/kg of other elements such as barium, chromium, cobalt, copper, nickel, vanadium and zinc were detected in soil samples from all borings. Water samples were not tested for these metals.

Trace amounts of beryllium (less than 0.4 mg/kg) were detected in soil samples from wells SP4-02 and SP4-03. Mercury was detected in a soil sample from well SP4-03 at a concentration of 0.12 mg/kg. Water samples from the site were not tested for these metals.

4.2.12.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site SP-4 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.12.2.1 Loss of Samples

No soil or water samples collected for laboratory analyses were lost from Site SP-4.

4.2.12.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures

(see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results.

4.2.12.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Six soil samples were collected from 3 borings; all borings were completed as wells and 1 water sample was collected from each well. No out-of-control conditions occurred during drilling or water sampling operations at the site.

4.2.12.3 Significance of Findings for Site SP-4

Analytical methods detected organic compounds in soil and water samples from Site SP-4. Benzene was detected in water from well SP4-01 at a level exceeding the State of Alaska Primary Drinking Water Standard of 5 ug/L. Water samples from wells SP4-01, SP4-02 and SP4-03 had total petroleum concentrations of 3.3, 3.2, and 2.5 mg/L, respectively. In addition, a water sample from well SP4-03 exhibited a petroleum odor and sheen; therefore, State of Alaska Drinking Water Standards for petroleum hydrocarbons were exceeded.

There are interim State of Alaska cleanup guidelines for contamination of soil by petroleum hydrocarbons described in Section 4.1.1. A soil sample from well SP4-03 contained 270 mg/kg petroleum hydrocarbons. An HNu meter also detected organic vapors and a strong petroleum odor was recorded during the drilling of this well.

The probable source of petroleum hydrocarbons and volatile organics in the soil and water at this site is oil spilled at the railroad maintenance facility in the late 1960's (Engineering-Science, 1983).

Pathways of exposure are contact with and ingestion or uptake of contaminated ground or surface water. Contact with surface soils contaminated with petroleum hydrocarbons constitutes an additional pathway. Receptors of the contamination are humans, wildlife, fish and plants.

4.2.12.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. A soil gas survey at Site SP-4 showed detectable BTX contamination throughout the area south of the railroad (Figure 4.2.12.4). Several areas of unidentified organic contamination were detected during the survey. Wells SP4-01 and SP4-03 were completed in or near these areas. Laboratory analyses of water samples from these wells confirmed the soil gas results; petroleum hydrocarbons were detected in samples from wells SP4-01, SP4-02 and SP4-03. General concentration lines have been constructed for the soil gas data, but there is insufficient data from other sources to allow three-dimensional temporal or higher-definition spatial mapping.

4.1.12.3.2 Contaminant Migration

Volatile organics are probably migrating in the groundwater as evidenced by benzene detected in a water sample from well SP4-01. This well is situated downgradient from well GW-4A sampled as part of the investigation for Site SP-11 (Section 4.2.14). A water sample from well GW-4A also contained benzene, although at a concentration

less than that detected in well SP4-01. The actual spill location of Site SP-4 is not clearly defined by past reports, and the contamination in well SP4-01 may be due to a spill at Site SP-11. Well SP4-03 is located north of the railroad tracks and was expected to be an upgradient well for this site. This well contained several petroleum hydrocarbon contaminants in the water and soil. Well SP4-02 is the most downgradient well at the site. Water from this well was contaminated with petroleum hydrocarbons, but not volatile organics. The origin of this contamination could be from either Sites SP-4 or SP-11.

4.2.12.3.2.1 Potential for Offsite and Off-Base Migration

Offsite migration of contamination has occurred at Site SP-4 as evidenced by contamination in the downgradient well (well SP4-02). Although the site boundaries have not been clearly defined, the spill most likely occurred further to the northeast near a railroad track spur. Since groundwater flow in the area is presumed to be to the southwest, well SP4-02 is offsite of Site SP-4.

The soil gas survey detected contamination encompassing about 16 acres, and covering areas to the north, south, east and west of the presumed spill site. However, contamination to the east may have originated due to a spill at Site SP-11, located to the east of Site SP-4.

Should contamination from Site SP-4 reach the Ship Creek, less than 500 feet to the southwest, it would be carried off-Base by the creek water.

4.2.12.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site inferred that the direction of groundwater flow is to the south-southwest with a gradient of about

60 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g, water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of the migration rate of the dissolved chemicals.

4.2.12.3.2.3 Time of Travel to Receptors

The primary receptors at present are humans, wildlife, fish and plants. Primary pathways are ingestion of contaminated ground and surface water and handling or ingestion of contaminated soil. A secondary exposure route would be the ingestion of contaminated plants or fish. Ship Creek is located less than 500 feet southwest of Site SP-4. Hydraulic conductivity for this site has not been estimated; thus, time of travel to the creek cannot be determined. Any contamination reaching the creek is expected to become highly diluted within the creek water.

Active drinking water well BW-52 is about 3000 feet downgradient of the site at building 23-100. This well was sampled as part of this study (Section 4.2.24). Time of travel to this well cannot be estimated, as hydraulic conductivity values for the site have not been established. However, base well 52 is an artesian well, drilled to a depth of 166 feet (Phase II, Stage 2 Report, Dames and Moore 1987). The water from well is contained inside a casing as it flows through the zone of potential contamination detected at Site SP-4, and is unlikely to be affected by impacts from the site.

4.2.12.3.2.4 Applicability of Solute Transport Models

Solute transport models may be important at Site SP-4. Wells installed to the south and southwest of the site may provide additional hydrogeologic data and allow the formation of more accurate solute transport models. The results of this modeling would help to determine the potential risk for downgradient water supplies and surface water.

4.2.12.3.2.5 Expected Spatial and Temporal Variations in Concentration

Contamination by petroleum hydrocarbons was detected in only 1 soil sample collected at the site; this was a sample taken at a depth of 5 feet.

A soil gas survey detected contamination by BTX and unidentified organics encompassing an area of about 16 acres. The actual spill site is not known, therefore it can be assumed that some of this contamination is upgradient of the spill. Contamination to the east of, and including, well SP4-01 may be due to a different spill that occurred at Site SP-11.

The spatial extent of contamination in groundwater reaches at least to well SP4-02, which is about 500 feet downgradient of the presumed spill site. Well SP4-03 is upgradient of the spill site, but was found to be contaminated with petroleum hydrocarbons and volatile organics. Groundwater flow direction was predicted to be in a south-southwest direction; however, seasonal and temporal effects may alter the direction of flow, allowing contamination from Site SP-4 to reach upgradient to well SP4-03.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of the contaminants is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.12.3.3 Baseline Risk Assessment

The following sections evaluate the contamination in relation to exposure routes, receptors, and health effects.

4.2.12.3.3.1 Waste Characterization

The primary wastes at the site are petroleum hydrocarbons and volatile organics. Total petroleum hydrocarbons were detected in soil and water samples at Site SP-4. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects. Benzene was detected in water from 1 well. Benzene, ethylbenzene, toluene, and xylenes are all common constituents of the fuels, oils, and solvents possibly spilled at this site.

4.2.12.3.3.2 Source and Release Characterization

Petroleum hydrocarbons and volatile organics were probably released to the environment as the result of an oil spill near the railroad maintenance facility. The amount and specific type of oil spilled was never recorded. It is not known if any recovery activities occurred or were successful.

4.2.12.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons and volatile organics released to the environment at Site SP-4 includes long-term natural degradation, dispersion of the contaminants through runoff, or uptake by living

organisms. Another possible fate is the volatilization of fractions that have vapor pressures (v.p.) greater than 1 mm of Hg (v.p. of benzene is 100 mm at 26.1 C).

Dissolved contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration with the groundwater through the process of advection. Additional transport can occur in the form of surface runoff or release of vapor to the atmosphere. Finally, contaminated soil or water from the site can be transported through human intervention.

4.2.12.3.3.4 Exposure Pathways

At present, the exposure pathway for humans, fish and wildlife is contact with or ingestion of contaminated ground or surface water, fish, or plants. Another pathway is the contact with or handling of contaminated surface soils at well SP4-03.

4.2.12.3.3.5 Identification of Receptors

Receptors are humans, fish, wildlife and plants. Human receptors include anyone drinking water from base well 52, ingesting water and fish from Ship Creek, or handling surface soils near well SP4-03. Plants in the contaminated area may become contaminated since surface and near-surface soils have been shown to be contaminated at well SP4-03.

4.2.12.3.3.6 Threat to Human Health

A possible threat to human health exists from the drinking of water from base well 52. Base well 52 was sampled as part of this investigation (Section 4.2.24). The sample was found to contain petroleum hydrocarbons, but no volatile organics. Due to the low

toxicity of petroleum hydrocarbons, and the artesian well design, any threat to human health from drinking water from base well 52 is assessed as low.

Another threat to human health is the drinking of Ship Creek water, or the ingestion of fish from Ship Creek. As part of this study, water and sediments were collected and analyzed from a point on Ship Creek, southwest and downgradient from Site SP-4. The samples did not contain petroleum hydrocarbons or volatile organic compounds above method detection limits. The threat to human health from exposure to Ship Creek water is minimal to nonexistent.

4.2.12.3.3.7 Carcinogenic Risks

Benzene, a known human carcinogen, was detected in a water sample from well NS4-01 at a concentration of 27 ug/L, which is over the State of Alaska Primary Drinking Water Standard of 5 ug/L. Benzene is known to cause bone marrow depression, leukemia, and imcomplete organ development.

4.2.12.3.3.8 Threat to Wildlife

Threat to wildlife is possible through ingestion of contaminated surface waters. Ship Creek constitutes the nearest downgradient surface water body. The threat is minimal to non-existent due to the distance of the site from the surface water of Ship Creek, the high dilution rate of creek water, and the fact this study found creek water and sediments to be uncontaminated.

4.2.12.4 Prioritization of Sites for Remedial Alternatives

Concentrations of benzene in groundwater at this site exceeded State of Alaska standards. Receptors are present, but distant. Site SP-4

should be combined with the adjacent Site SP-11 for data analysis and reporting purposes. Site SP-4 is recommended for medium-priority classification. Specific recommendations for the combined SP-4/11 site are discussed in Section 4.2.14.4.

4.2.13 Discussion of Results for Sites SP-7 and SP-10, Pumphouse No. 3

Pumphouse No. 3 (building 42-103) has been the site of several large and small fuel spills (Figure 4.2.13.1). During 1964 to 1965, a 50,000 gallon spill of JP-4 occurred as a result of a pump failure. In 1980, approximately 36,000 gallons of the jet fuel were spilled onto the ground through a vent pipe. Little or no JP-4 was recovered from either of these spills, and almost all of the spilled fuel infiltrated down into the gravelly soil near the pumphouse.

4.2.13.1 Presentation of Results for Site SP-7 and SP-10

Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site location maps.

4.2.13.1.1 Site Geology

The SP-7/10 site is located on flat terrain just north of the East-West runway at an elevation of about 175 feet. The site has been cleared of trees and brush, and unpaved areas are periodically mowed. The site is situated on coarse glacial outwash deposits of sand and gravel which overlie fine-grained units of the Bootlegger Cove Formation at a depth greater than 30 feet.

Four borings, all of which were completed as monitoring wells, were drilled at the site. Boring logs for these wells are included in Appendix C. An interpreted gamma log of well SP7/10-01 is provided in Appendix D. A schematic geologic cross section of the site is provided in Figure 4.2.13.2.

4.2.13.1.2 Site Hydrogeology

Site SP-7/10 is underlain by sands and gravels with a water table depth of approximately 12 to 22 feet. Groundwater flows toward the south-southwest (Figure 4.2.13.3). The average gradient is approximately 20 feet per mile. Hydraulic conductivity values at this site have not been determined.

4.2.13.1.3 Analytical Results

Field analytical results and observations, and laboratory analytical results are discussed in the following sections.

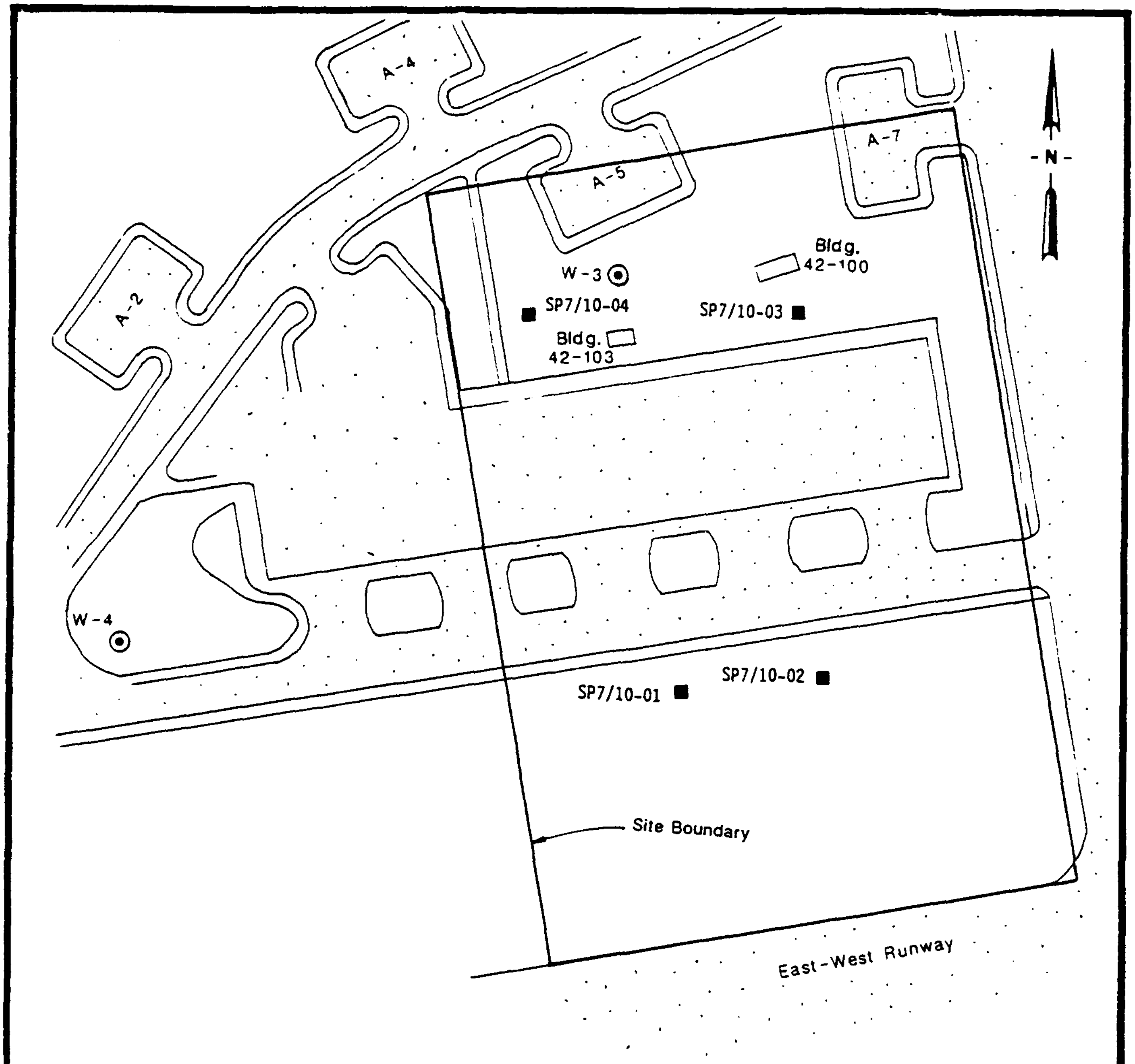
4.2.13.1.3.1 Field Analytical Results and Observations

Results of a soil gas survey conducted at Site SP-7/10 are presented in Figure 4.2.13.4 and on Table 4.2.13.1. Isoconcentration contours have been drawn based on the findings of the field analysis. The soil gas survey indicated areas of BTX and unidentified organic contamination. In addition to the soil gas survey, the following visual evidence of contamination was observed at Site SP-7/10 in the field:

- Well SP7/10-02 - An HNu reading of 0.3 ppm was recorded on a soil sample taken at a depth of 10 feet.

- Well SP7/10-04 - The following HNu readings were recorded on soil samples at the depths indicated.

  5 feet - 40 ppm
  10 feet - 100 ppm
  15 feet - 150 ppm (petroleum odor was also detected)
  20 feet - 130 ppm (petroleum odor was also detected)
  25 feet - 40 ppm (petroleum odor also detected)
  30 feet - 110 ppm (petroleum odor also detected)



Legend:

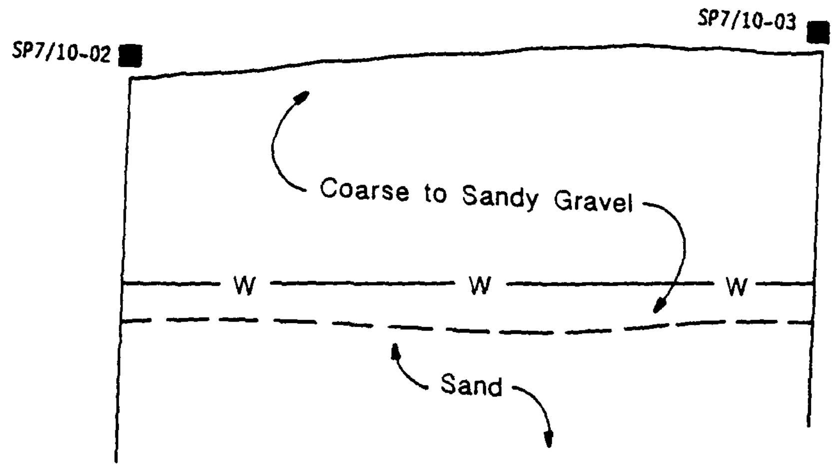
W-3 — Monitoring Well Location, Phase II, Stage 1

SP7/10-01 — Monitoring Well Location Stage 3

LOCATION MAP
SITE SP-7/10

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.13.1

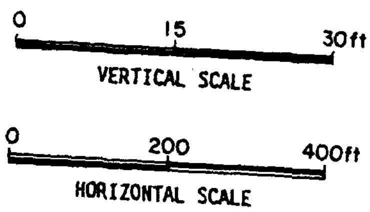


Legend:

SP7/10-01 ■ Monitoring Well Location Stage 3

— W — Projected Water Table

— — — Inferred Contact



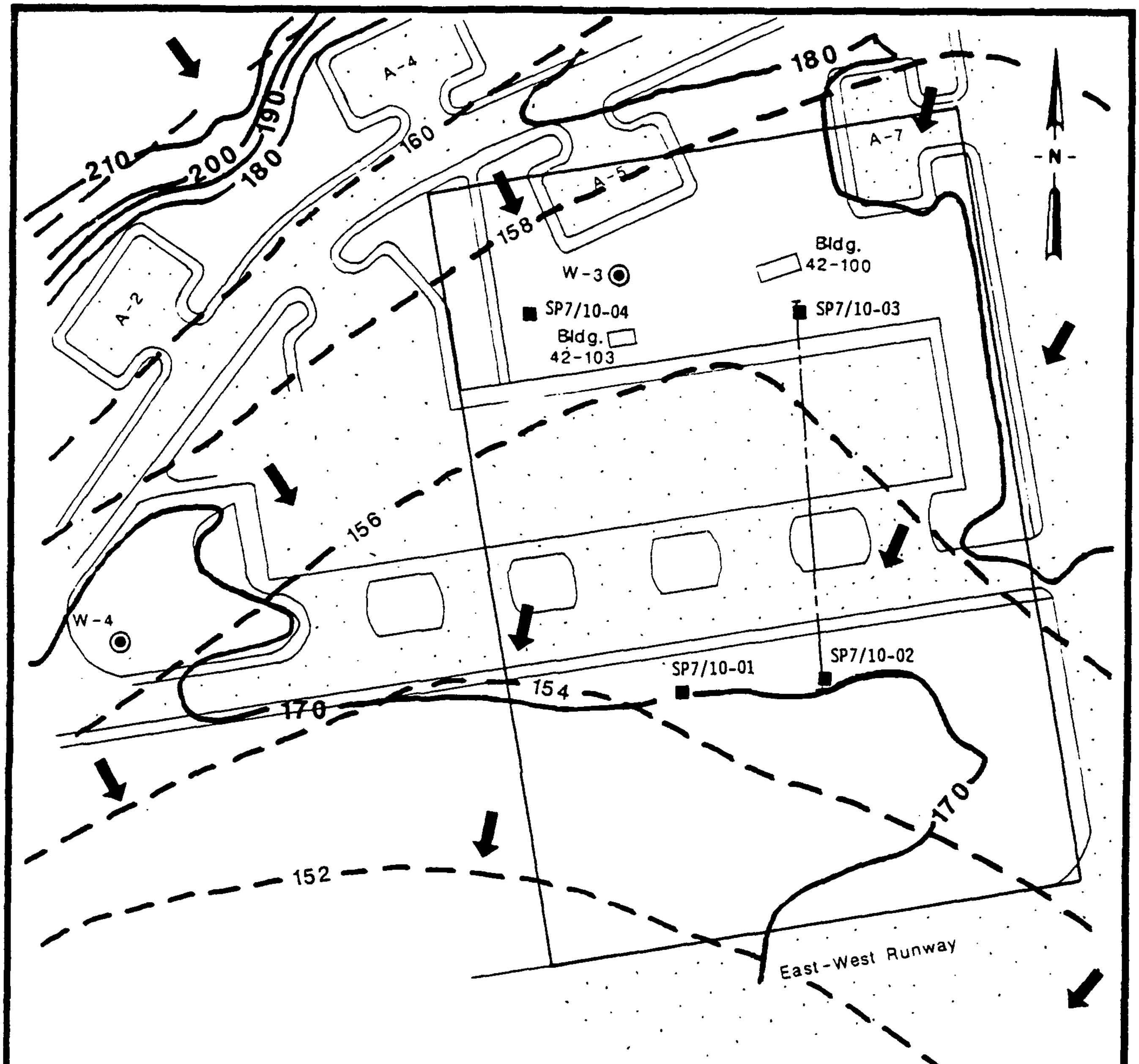
Notes:

1. Horizontal scale: 1 inch = 200 feet.
2. Vertical scale: 1 inch = 15 feet.
3. Cross section location shown on Figure 4.2.13.3

GEOLOGIC CROSS SECTION
SITE SP-7/10

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.13.2



Legend:

W-3 ◉ Monitoring Well Location, Phase II, Stage 1

SP7/10-01 ■ Monitoring Well Location Stage 3

--230-- Water table contour. Contour intervals: 2ft.

➔ Approximate direction of groundwater flow.

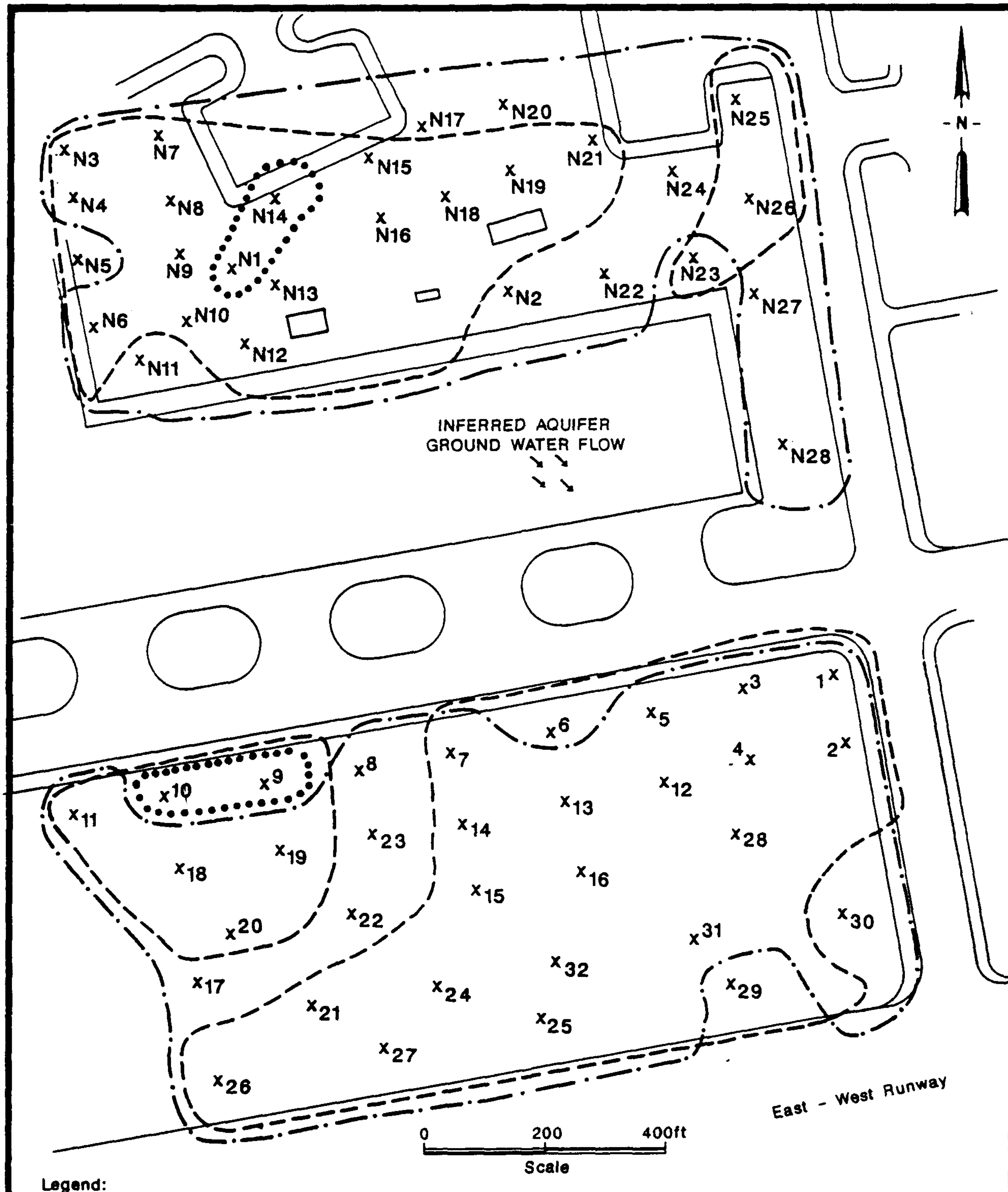
—300— Landsurface elevation contour. Contour intervals: 10ft.

|— — —| Geologic Cross Section

HYDROGEOLOGIC MAP
SITE SP-7/10

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.13.3



Legend:

— · — · —	Detectable Unidentified Organic Contamination
— — — —	Detectable TPH Contamination
• • • • • • •	>10ppm TPH Contamination
x 3	Probe Location
x N2	Probe Location, North

SOIL GAS SURVEY
LOCATIONS AND RESULTS
SITE SP-7/10

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.13.4

Table 4.2.13.1. Summary of Soil Gas Chromatograph Analyses at Sites SP-7 and SP-10.

Probe No.	Depth (ft)	TPH (ppm)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)	Comments
1	7.5	.36	.01	TR	.07	1.06	Diesel; unidentified organic is at 1.15 RT
2	8	.43	-	TR	.04	1.08	Diesel
3	10	.64	TR	TR	TR	1.30	
4	7	3.55	-	.63	TR	.99	Diesel
5	8	2.17	-	TR	-	1.03	Diesel and JP4
6	10	.61	-	.15	.07	-	
7	5	.28	.01	TR	.04	.35	
8	5	TR	-	TR	TR	.51	
9	10	36.28	-	8.05	9.60	-	
10	10	15.32	-	5.48	2.28	-	
11	10	.16	-	.18	TR	.04	
12	10	1.64	-	.25	-	.33	
13	10	.68	-	.68	-	.01	
14	10	.43	-	.43	TR	.24	
15	10	.46	-	.46	TR	.13	
16	10	1.06	-	1.03	-	.26	
17	8	TR	-	-	-	.05	
18	10	2.43	-	.54	.189	.51	
19	10	TR	-	-	-	1.48	
20	10	2.69	-	.19	2.5	.25	
21	10	1.66	-	-	1.66	.44	
22	10	.83	-	-	-	.02	
23	10	-	-	-	-	.27	
24	10	.38	-	-	.38	.28	
25	6.5	1.01	-	TR	1.01	.33	
26	10	6.79	-	-	1.55	3.03	
27	10	.92	-	-	.92	.24	
28	10	.49	-	.49	TR	.21	
29	10	7.56	1.14	.77	3.23	-	
30	10	TR	-	TR	TR	3.04	
31	10	3.63	-	.24	3.39	1.05	
32	10	3.01	-	3.01	-	.95	
1N	7	14.71	-	6.19		.54	JP4 and diesel
2N	8	TR	-	TR	TR	.94	
3N	8	7.23	-	.91	-	.35	
4N	8	4.48	-	4.48	-	.36	

Table 4.2.13.1 (Continued)

Probe No.	Depth (ft)	TPH (ppm)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)	Comments
5N	6	1.42	.-5	.17	-		
6N	10	5.72	-	1.35	TR	.68	
7N	10	.93	.20	.24	TR	.62	
8N	10	2.25	-	.48	TR	.88	
9N	5.5	2.84	-	.31	TR	.11	
10N	10	5.04	-	1.29	TR	.80	
11N	10	TR	-	TR	TR	5.03	
12N	10	1.54	-	1.14	.39	.15	
13N	10	.08	-	.08	TR	.04	
14N	8	419	-	419	-	.03	JP4
15N	4.5	.35	-	-	.30	.31	
16N	10	9.83	-	TR	TR	.39	
17N	5.5	TR	-	-	TR	1.90	
18N	5	TR	-	-	TR	.70	
19N	7.5	2.82	-	1.85	.08	.05	
20N	7.5	TR	-	TR	TR	.15	
21N	10	.66	-	TR	TR	.16	
22N	10	TR	-	TR	-	.40	
23N	10	.23	-	.23	-		
24N	10	TR	-	TR	-	.55	
25N	10	.16	-	-	.11	4.45	
26N	10	2.25	-	-	1.87	.97	
27N	10	-	-	-	-	.74	
28N	10	TR	-	-	-	.45	

Note: Unidentified organics is reported in benzene equivalent ppm.
TR - Trace
RT - Retention Time

Field parameters measured at Site SP-7/10 during groundwater sampling are provided on Table 4.2.13.2.

4.2.13.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site SP-7/10 is presented on Table 4.2.13.3, and the sample plan for the basewide field investigation is included in Appendix B. Major petroleum-based contaminants identified from the laboratory analysis of samples collected at Site SP-7/10 are plotted in Figures 4.2.13.5 through 4.2.13.9. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well or test boring. Sampling depths are included for the soil samples. Isoconcentration lines were not drawn due to the few points having detectable contamination for each analyte. Results of analytical tests for metals and other contaminants are presented Table 4.2.13.4.

4.2.13.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site SP-7/10 are presented on Table 4.2.13.3.

Table 4.2.13.2 Field Parameters Site SP-7/10.

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
SP7/10-01	8/15/88	7.0	405	7.11	124	No odor or sheen
SP7/10-02	8/15/88	6.5	481	6.98	162	No odor or sheen
SP7/10-03	8/15/88	8.5	230	5.37	74	Slight POL odor only
SP7/10-04	8/15/88	8.0	415	6.72	156	Slight POL odor, sheen
W-3	8/15/88	8.8	495	6.94	182	Pure product
W-4	8/15/88	9.1	458	6.99	178	Slight POL odor, sheen

Table 4.2.13.3 Requested Analyses for Laboratory Samples at Site SP-7/10.

SOIL/SEDIMENT

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
8240	Volatile Organic Compounds
160.3	Soil Moisture Content

WATER

Test Number	Analysis
300	Common Anions
602	Purgeable Aromatics

Note: TPH analysis of groundwater samples was requested. However, holding times were exceeded.

4.1.13.1.5 Discussion of Analytical Data

Volatile organic compounds were detected at Site SP-7/10. However, the concentrations were generally low and confined to the west and northwest portions of the site (Figures 4.2.13.5 through 4.2.13.9). Benzene, toluene, ethylbenzene, and xylenes (BETX) were detected in the soil and water sample from well SP7/10-04 with the total BETX concentration of the water sample measuring 14,600 ug/L. The soil sample from well SP7/10-04 contained toluene (1.0 mg/kg), ethylbenzene (1.1 kg/mg) and xylenes (13 mg/kg). Water samples from wells W-3 and W-4 contained total BETX concentrations of 12600 and 1440 ug/L, respectively. Total petroleum hydrocarbons concentration was 420 mg/kg in the 20 foot soil sample from well SP7/10-04.

4.2.13.2 Sampling or Analytical Problems

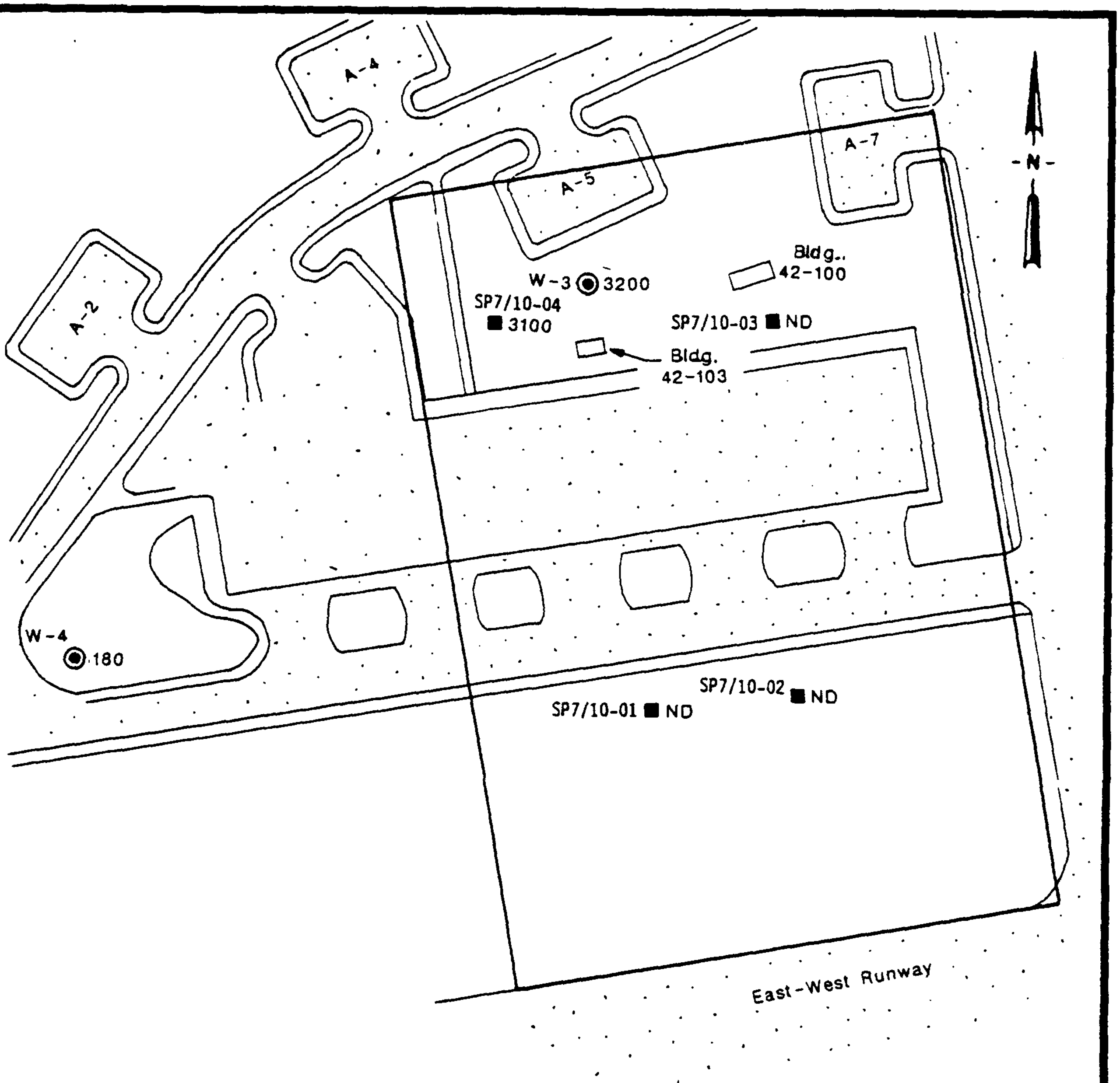
Sampling or analytical problems that may have been encountered at Site SP-7/10 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.13.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis were lost from Site SP-7/10.

4.2.13.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is possible, but unlikely, that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds usually associated with laboratory cross-contamination were detected in samples from Site SP-7/10.



Legend:

W-4 — Monitoring Well Location, Phase II, Stage 1

SP7/10-01 — Monitoring Well Location Stage 3

Well Number
Well Location
Depth of Sample (ft)
Analyte Concentration
[Water: µg/L
ND:Non-Detected
Soil: mg/kg]

(Symbol)
10/300
SP7/10-01

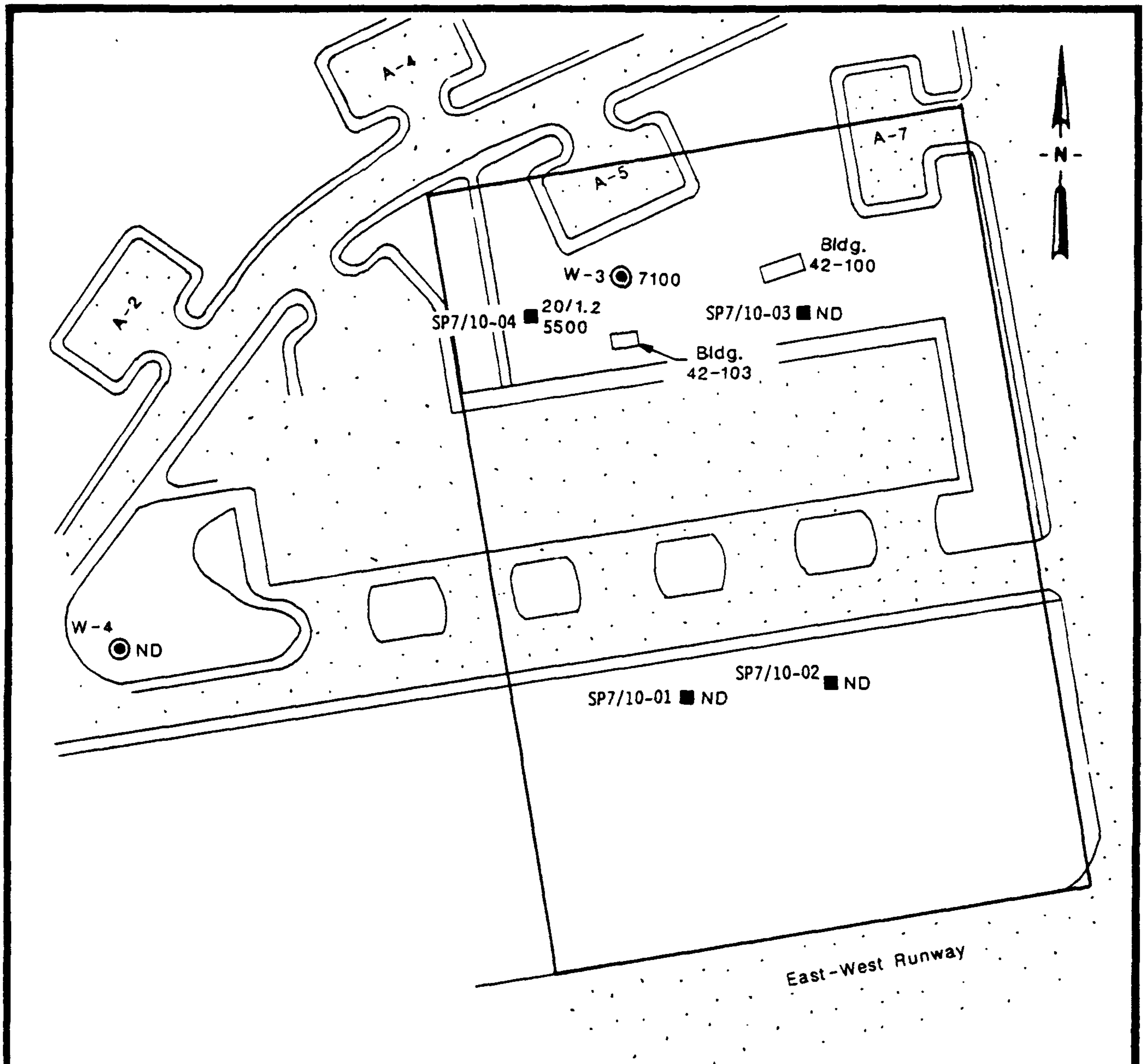
Note: Water sample concentrations not asociated with a depth.

0 200 400ft
Scale

BENZENE
CONCENTRATION
SITE SP-7/10

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.13.5



Legend:

W-4 Monitoring Well Location, Phase II, Stage 1

SP7/10-01 Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

(Symbol) 10/300

SP7/10-01

Water: µg/L
ND: Non-Detected
Soil: mg/kg

Note: Water sample concentrations not asociated with a depth.

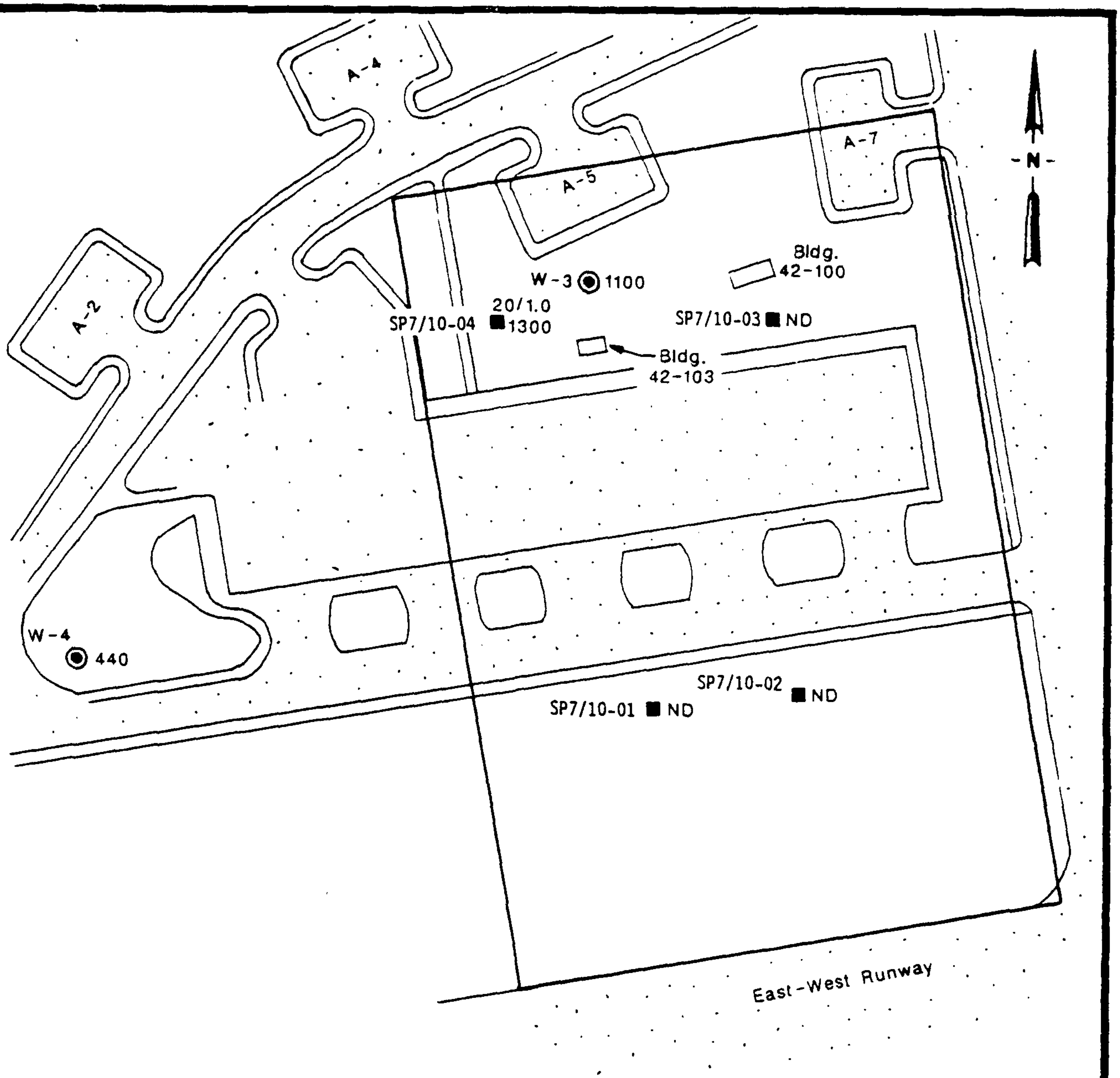
0 200 400ft

Scale

TOLUENE CONCENTRATION SITE SP-7/10

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.13.6



Legend:

W-4 — Monitoring Well Location, Phase II, Stage 1

SP7/10-01 — Monitoring Well Location Stage 3

Well Number
Well Location
Depth of Sample (ft)
Analyte Concentration
[Water: µg/L
ND: Non-Detected
Soil: mg/kg]

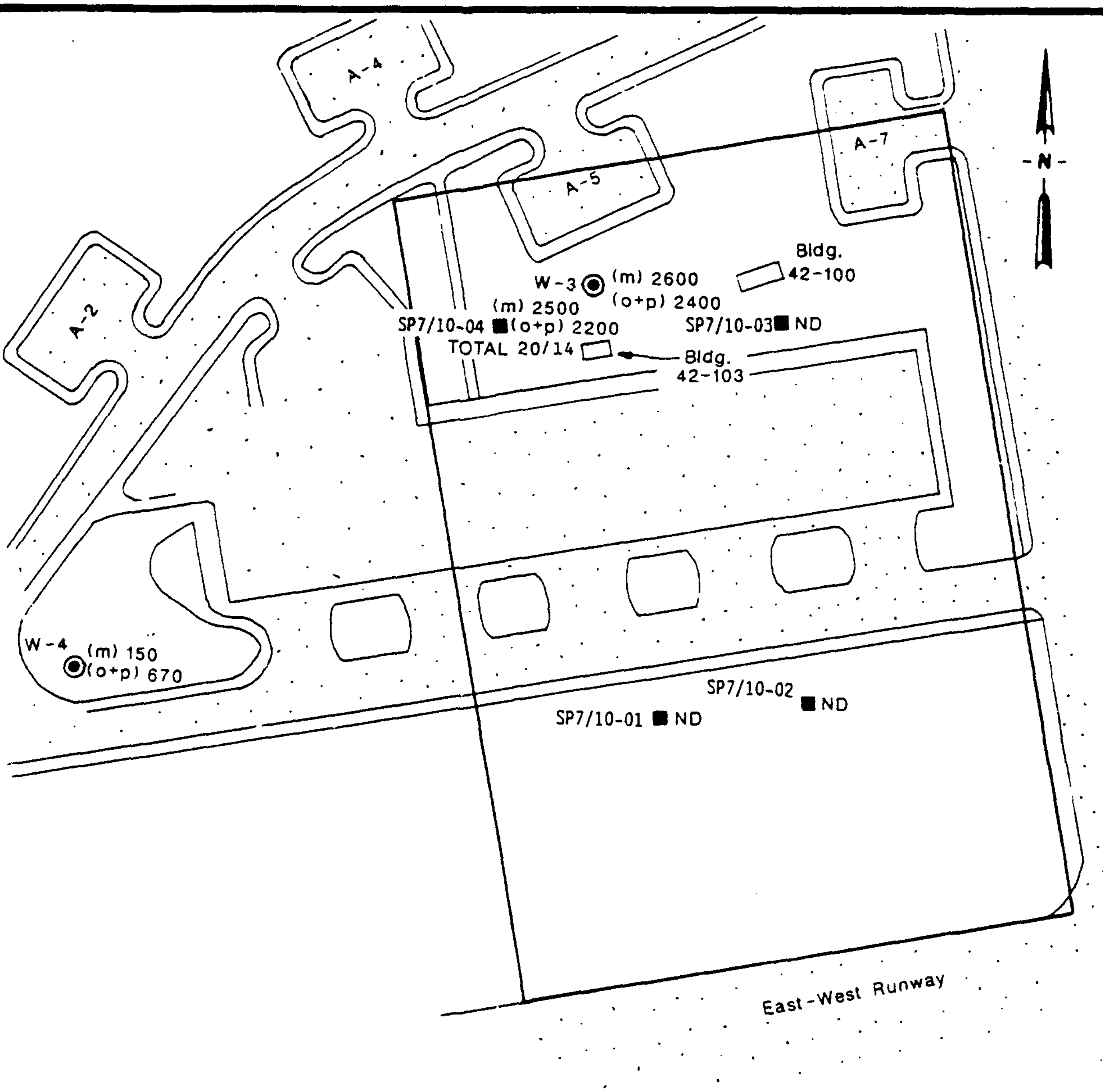
(Symbol) 10/300
SP7/10-01

Note: Water sample concentrations not asociated with a depth.

ETHYLBENZENE CONCENTRATION SITE SP-7/10

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.13.7



Legend:

W-4 — Monitoring Well Location, Phase II, Stage 1

SP7/10-01 — Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

(Symbol)

10/300

SP7/10-01

Water: µg/L
ND:Non-Detected
Soil: mg/kg

0 200 400ft

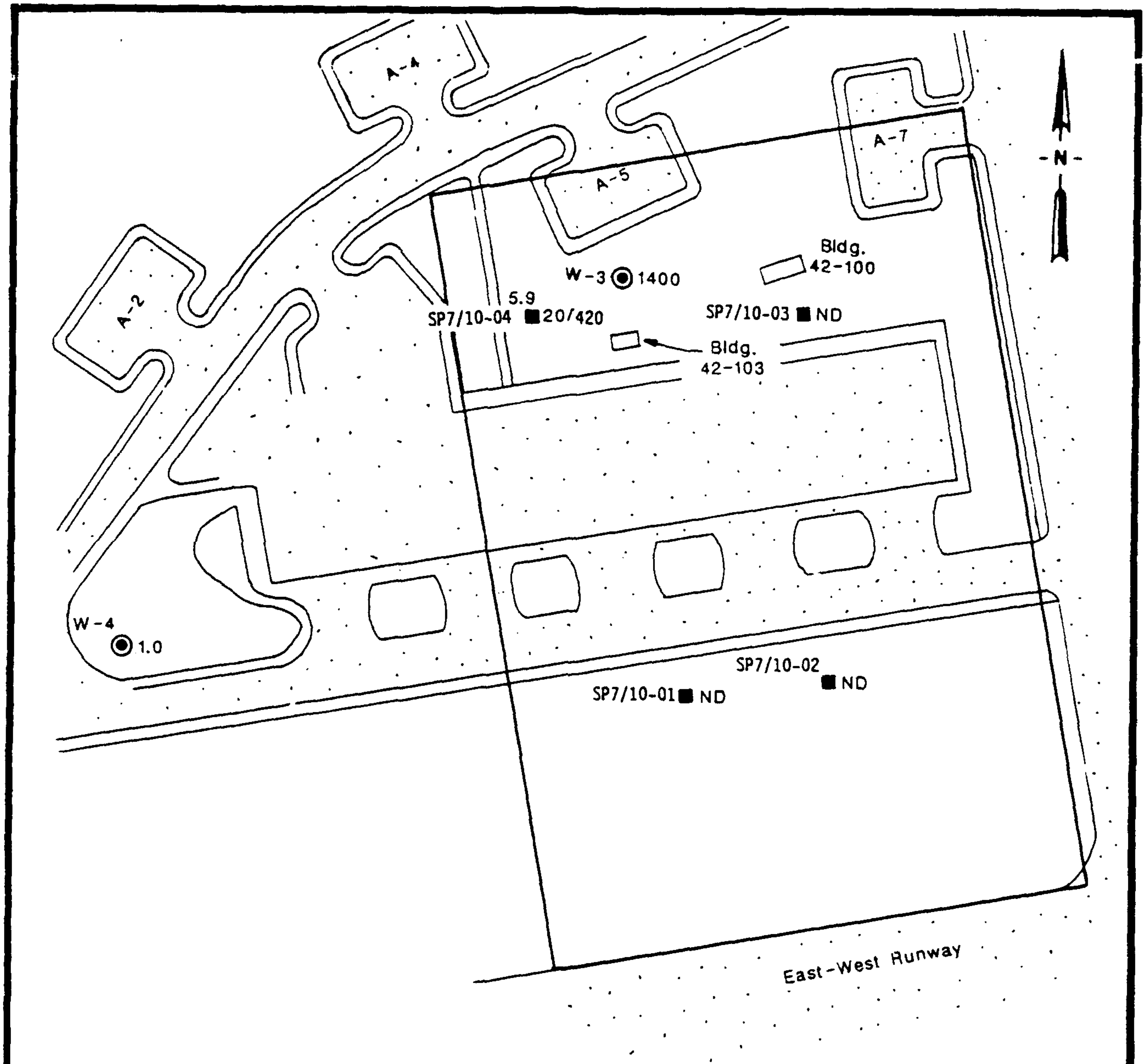
Scale

Note Water sample concentrations not associated with a depth.

(m), (o+p) AND TOTAL XYLENE CONCENTRATION
SITE SP-7/10

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.13.8



Legend:

W-4 — Monitoring Well Location, Phase II, Stage 1

SP7/10-01 — Monitoring Well Location Stage 3

Well Number
Well Location
Depth of Sample (ft)
Analyte Concentration

(Symbol) 10/300
SP7/10-01

Water: mg/L
ND: Non-Detected
Soil: mg/kg

Note: Water sample concentrations not asociated with a depth.

0 200 400ft
Scale

TOTAL PETROLEUM HYDROCARBON CONCENTRATION SITE SP-7/10

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.13.9

Table 4.2.13.4

Analytical Results - Site SP-7/10

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP7/10-03 10'-11.5' 0687-SO-086,GS-88-0001 001017-0003	SP7/10-03 25'-26.5' 0687-SO-086,GS-88-0002 001017-0004	SP7/10-02 10'-11.5' 0687-SO-085 GS-88-0001 000975-0001	SP7/10-02 20'-21.5' 0687-SO-085 GS-88-0002 000975-0002	SP7/10-02 20'-21.5' DUPLICATE 0687-SO-085 GS-88-0002 DU 000975-0002	W-3 0687-NG-088-GN-88-0001 001268-0010
Benzene	EPA 602	ug/L	5						3200.
Ethyl benzene	EPA 602	ug/L	700						1100.
MOISTURE	GRAV.	%							
OIL & GREASE	413.2	mg/L							
TDS	160.1	mg/L	500						
TOC	415.1	mg/L							
Toluene	EPA 602	ug/L	2,000						7100.
Total Petroleum Hydrocarbons	EPA 418.1								1400.
Total Solids	160.3	%		96.0	86.5	96.1	87.8	88.4	
Total xylenes	Method 8240	mg/kg	500						
m-Xylene	EPA 602	ug/L	440						2600.
o & p-Xylene(s)	EPA 602	ug/L	440						2400.

Table 4.2.13.4

Analytical Results - Site SP-7/10

			Standards, Criteria and Action Levels	W-3	W-3	W-3	W-3	W-3	SP7/10-04	SP7/10-04 10'-11.5'	SP7/10-04 20'-21.5'	W-4
Parameter	Method	Units	Federal/State	GN840274	W-3-5	W-3/23	W-3/46	W-3/48	0687-NG-087-GN-88-0003 001268-0009	0687-SO-087,GS-88-0001 001017-0001	0687-SO-087,GS-88-0002 001017-0002	0687-NG-089-GN-88-0001 001268-0011
Benzene	EPA 602	ug/L	5			4800			3100.			180.
Ethyl benzene	EPA 602	ug/L	700			620			1300.		1.05	440.
MOISTURE	GRAV.	%			6.4							
OIL & GREASE	413.2	mg/L		56	130							
TDS	160.1	mg/L	500				470					
TOC	415.1	mg/L		8								
Toluene	EPA 602	ug/L	2,000			8200			5500.		1.15	
Total Petroleum Hydrocarbons	EPA 418.1							51	5.9		416	1.0
Total Solids	160.3	%								95.5	86.5	
Total xylenes	Method 8240	mg/kg	500								13.61	
m-Xylene	EPA 602	ug/L	440			3000			2500.			150.
o & p-Xylene(s)	EPA 602	ug/L	440			2600			2200.			670.

Table 4.2.13.4

Analytical Results - Site SP-7/10

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-4 GN840274	W-4 W-4-3	W-4 W-4/44	W-4 W-4/45	SP7/10-01 15'-16.5' 0687-SO-084 GS-88-01 000975-0004
Benzene	EPA 602	ug/L	5					
Ethyl benzene	EPA 602	ug/L	700					
MOISTURE	GRAV.	%			14			
OIL & GREASE	413.2	mg/L		6	106			
TDS	160.1	mg/L	500			500		
TOC	415.1	mg/L		5				
Toluene	EPA 602	ug/L	2,000					
Total Petroleum Hydrocarbons	EPA 418.1						1.9	
Total Solids	160.3	%						86.2
Total xylenes	Method 8240	mg/kg	500					
m-Xylene	EPA 602	ug/L	440					
o & p-Xylene(s)	EPA 602	ug/L	440					

4.2.13.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Eight soil samples were collected from 4 borings; all borings were completed as monitoring wells and one water sample was collected from each well. In addition, 2 previously existing wells were sampled. No out-of-control conditions occurred during drilling or water sampling operations at the site.

4.2.13.3 Significance of Findings

Analytical methods detected volatile organic compounds in water samples from Site SP-7/10 (Section 4.2.13.1). Benzene was detected in water from wells W-3, W-4, and SP7/10-04 at levels exceeding the State of Alaska Primary Drinking Water Standard of 5 ug/L. Water from well W-3 also contained toluene at a level exceeding the State of Alaska proposed regulatory limit of 2000 ug/L. Water samples from wells W-3, W-4, SP7/10-03 and SP7/10-04 had a petroleum odor and sheen thereby exceeding State of Alaska Drinking Water Standards for petroleum hydrocarbons. Pure product was collected from well W-3 during water sampling activities. During sampling of this well approximately one-half inch of product was recovered from each bailer.

There are no State of Alaska or EPA standards for contamination of soil. A petroleum odor and sheen were detected in soil samples during drilling of well SP7/10-04. An HNu meter also detected organic vapors during the drilling of well SP7/10-02 and SP7/10-04.

Benzene and toluene were detected at levels exceeding State of Alaska standards in a 1986 water sample from well W-3 (Dames and Moore 1987). A sample collected in 1986 from well W-4 did not detect volatile organic compounds or petroleum hydrocarbons.

The apparent source of petroleum hydrocarbons and volatile organics in the soil and water at this site is spills of JP-4 that occurred near pumphouse No. 3 (building 42-103). Spills of 50,000 and 36,000 gallons have been reported.

4.2.13.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. A soil gas survey at Site SP-7/10 indicated detectable BTX contamination throughout the areas north of the east-west runway and south of the hardstands (Figure 4.2.13.4). Several areas of BTX contamination greater than 10 ppm were detected during the survey. Wells SP7/10-04 and W-3 at Site SP-7/10 were completed in or near these areas. Laboratory analyses of the water samples from these wells confirmed the soil gas results; volatile organic compounds were detected in water from wells W-3 and SP7/10-04. However, laboratory analyses of soil and water from wells SP7/10-01 and SP7/10-02, which are both situated in an area of positive soil gas readings, showed no contamination above method detection limits. General concentration lines have been constructed for the soil gas data, but there is insufficient data from other sources to allow three-dimensional temporal or higher-definition spatial mapping.

4.2.13.3.2 Contamination Migration

Volatile organics are migrating in the groundwater at Site SP-7/10. Groundwater flow at the site is toward the south-southwest, and contamination by benzene, toluene, ethylbenzene and xylenes seen in well W-3 extends downgradient through well SP7/10-04 to well W-4. The highest concentrations of the contaminants were found in the most upgradient well, (well W-3), and the lowest were detected in the well located furthest to the southwest (well W-4). Water samples collected in 1986 from well W-4 were not contaminated; apparently the

contamination has moved into this area since 1986. Two wells located to the southeast (wells SP7/101 and SP7/10-02) did not contain contamination above method detection limits.

4.2.13.3.2.1 Potential for Offsite and Off-Base Migration

Offsite migration of contamination has occurred at Site SP-7/10 as evidenced by contamination in the most downgradient well (well W-4). Although the overall site boundaries have not been clearly defined, the actual spill site is located about 1000 feet to the northeast of this well, near building 42-103. Since groundwater flow in the area is presumed to be to the south-southwest, well W-4 is downgradient of the spill site. Previous water samples from this well were not found to be contaminated (Dames and Moore 1987).

The soil gas survey detected contamination encompassing 2 areas, 1 22-acre area located in the vicinity of building 42-100 and an 18-acre area located 600 feet to the south.

Should contamination from Site SP-7/10 reach the Cherry Hill Ditch, 4000 feet to the southwest,it could be carried off-Base by water in the ditch.

4.2.13.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site inferred that the direction of groundwater flow is to the south-southwest with a gradient of about 20 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to

temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of the migration rate of the dissolved chemicals.

4.2.13.3.2.3 Time of Travel to Receptors

The primary receptors at present are humans, wildlife, and plants. Primary pathways are ingestion of contaminated ground and surface water. A secondary exposure route would be the ingestion of contaminated plants. Cherry Hill Ditch is located about 4000 feet southwest of Site SP-7/10. Hydraulic conductivity has not been determined; thus, time of travel to the creek cannot be estimated. In addition, runway drains empty into the ditch. Any contamination entering the drains from Site SP-7/10 would reach the ditch in a very short amount of time.

Base well 16, a source of drinking water, is about 3000 feet downgradient of the site at building 32-189. Time of travel to the this well has not been determined because hydraulic conductivity values have not been fully established. However, base well 16 is an artesian well, drilled to a depth of 228 feet (Phase II, Stage 2 Report, Dames and Moore 1987). The water from the well is contained inside a casing as it flows through the zone of contamination detected at Site SP-7/10, and is unlikely to be affected by impacts from the site.

4.2.13.3.2.4 Applicability to Solute Transport Models

Solute transport models may be important at Site SP-7/10. Wells installed to the south and southwest of the site may provide additional hydrogeological data and allow the formation of more accurate solute transport models. The results of this modeling would

help to determine the potential risk for downgradient water supplies and surface water.

4.2.13.3.2.5 Expected Spatial and Temporal Variations in Concentration

Contamination by petroleum hydrocarbons was detected in one soil sample collected at the site; this was a sample from a 20-foot depth in well SP7/10-04. The spatial extent of contamination in groundwater reaches at least to well W-4 at Site SP-7/10, which is about 1000 feet downgradient of the presumed spill site.

A soil gas survey detected contamination by BTX and encompassing 2 areas, 1 about 22 acres and the other about 18 acres. The actual spill site is reportedly situated near building 42-103. Some of the contamination detected by the soil gas survey is upgradient from the building.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of the contaminants is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.13.3.3 Baseline Risk Assessment

The contaminant in relation to exposure routes, receptors, and health effects are evaluated in the following sections.

4.2.13.3.3.1 Waste Characterization

The primary wastes at the site are petroleum hydrocarbons and volatile organic compounds. Total petroleum hydrocarbons were detected in soil

and water samples at Site SP-7/10. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects. Benzene was detected in water from three of the wells at Site SP-7/10. In 2 cases this compound was detected at levels nearly 650 times the State of Alaska standard of 5 ug/L, and the third well contained benzene at a level 36 times the standard. This volatile organic compound is a known human carcinogen. Toluene, ethylbenzene, and xylenes were detected in water samples from the site. These volatile organics are less toxic than benzene; however, they were detected above the proposed MCLs of 2,000, 700 and 440 ug/L, respectively.

4.2.13.3.3.2 Source and Release Characterization

Petroleum hydrocarbons and volatile organics were released to the environment as the result of JP-4 leaks and spills near the railroad maintenance facility. Two leaks were recorded as being 50,000 and 36,000 gallons each.

4.2.13.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons and volatile organics released to the environment at Site SP-7/10 includes long-term natural degradation, dispersion of the contaminants through surface runoff, or uptake by living organisms. Another possible fate is the volatilization of fractions that have vapor pressures greater than 1 mm of Hg. These fractions include benzene (vapor pressure (v.p.) 100 mm at 26.1C); toluene (v.p. 36.7 mm at 30C); ethylbenzene (v.p. 10 mm at 25.9C); and p-xylene (v.p. 10 mm at 27.8C).

Dissolved contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration with the groundwater through the process of advection. Additional transport can occur in the form of surface runoff or release of vapor

to the atmosphere. Finally contaminated soil or water from the site can be transported through human intervention.

4.2.13.3.3.4 Exposure Pathways

At present, the exposure pathway for humans and wildlife is contact with or ingestion of contaminated ground or surface water, or plants.

4.2.13.3.3.5 Identification of Receptors

Receptors are humans, wildlife, and plants. Potential human receptors include anyone drinking from base well 16, or ingesting or handling water from Cherry Hill Ditch. Plants are possible but unlikely receptors due to the lack of large trees in the vicinity of the runway, and the depth to groundwater (nearly 20 feet). However, humans may be exposed to contamination by the ingestion of plants or berries that have taken up ditch water. Fish were not observed in the ditch.

4.2.13.3.3.6 Threat to Human Health

A possible threat to human health is the drinking of water from base well 16. However, due to the distance from Site SP-7/10, and the design and artesian nature of the well, any threat to human health from drinking water from base well 16 is assessed as low.

A possible threat to human health is the drinking of or contact with water from Cherry Hill Ditch. Samples from the ditch were analyzed as part of this study (Section 4.2.19). Contaminant concentrations from water in the Cherry Hill Ditch were within acceptable drinking water limits, and the overall threat from ditch water is assessed as low (Section 4.2.19).

4.2.13.3.3.7 Carcinogenic Risks

Benzene, a known carcingen (Table 4.1.8), was detected in water samples from wells SP7/10-04, W-3 and W-4 at concentrations of 3100, 3200, and 180 ug/L, respectively. These values exceed the State of Alaska Primary Drinking Water Standard of 5 ug/L.

4.2.13.3.3.8 Threat to Wildlife

Threat to wildlife is possible through ingestion of contaminated surface waters. Cherry Hill Ditch constitutes the nearest surface water body. However, the threat is minimal since contaminant concentrations in ditch waters were within State of Alaska standards (Section 4.2.19).

4.2.13.4 Prioritization of Sites for Remedial Alternatives

Concentrations of benzene in water samples from this site greatly exceeded State of Alaska Primary Water Quality Standards. For this reason and due to the presence of a downgradient drinking water well, and proximity to runway drains emptying into Cherry Hill Ditch, the site is a feasibility study site which requires further investigation.

Further investigative work at this site should begin with the installation of 4 additional wells to delineate plume dispersion. One of the new wells should be located near SP7/10-04. This well should be screened in the deeper region of the unconfined aquifer. The 3 other wells should be located downgradient of the site. One of these new wells should be a dual completion well, screened in both the upper and lower regions of the aquifer. Data from the deeper region of the

aquifer will be used to delineate the vertical extent of concentration. Also, a shallow soil boring should be located near well W-4. Water from the new wells and from the presently-existing wells should be sampled and tested for vola'ile organic compounds and petroleum hydrocarbons.

4.2.14 Discussion of Results for Site SP-11, JP-4 Fuel Line Leak

An undetermined amount of JP-4 fuel was lost at Site SP-11 in 1978 as a result of a crack in an underground pipe (Figure 4.2.14.1). The pipe was repaired, but fuel continued to seep from the bank of a nearby stream.

4.2.14.1 Presentation of Results at Site SP-11

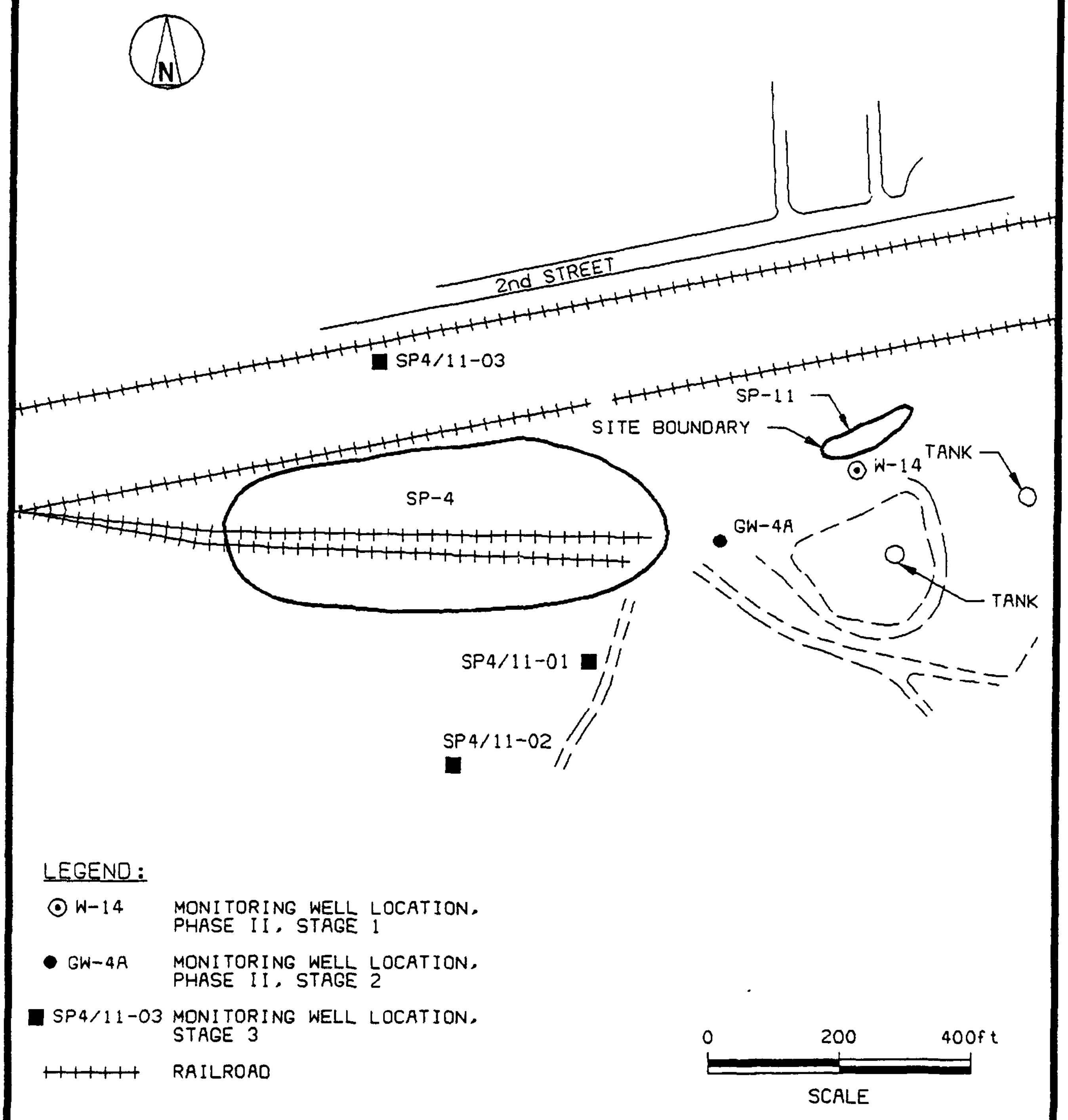
Results of the geologic and hydrogeologic investigations are presented below. Analytical results are tabulated and presented on the site location maps.

4.2.14.1.1 Site Geology

Site SP-11 is located at an elevation of about 130 feet at the base of the bluff bordering the Ship Creek floodplain. The site is underlain primarily by man made fill and recent alluvium consisting of sands and gravel and some silt. A schematic geologic cross section is presented in Figure 4.2.14.2. The site was well vegetated with alders.

4.2.14.1.2 Site Hydrogeology

Site SP-11 is underlain by fill and sands with some silts and gravels. Water table depths range from approximately 1 to 35 feet. The direction of groundwater flow is based on regional trends and water level measurements at 9 wells in the area (Figure 4.2.14.3). The groundwater flow is south-southwest with a gradient of approximately 60 feet per mile. Hydraulic conductivity values have not yet been established for this site.

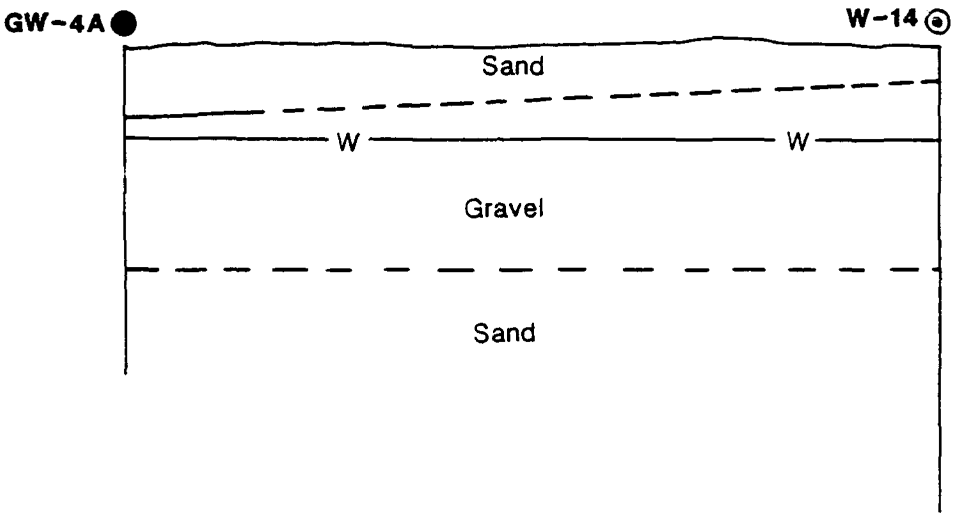


LOCATION MAP

SITE SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.14.1



Legend:

- W-14 ⦿ Monitoring Well, Phase II, Stage I
- GW-4A ● Monitoring Well, Phase II, Stage II
- —W— Projected Water Table
- ——— - - - Geologic Contact, Dashed Where Inferred
- ++++++++++ Railroad

0 10 20ft
VERTICAL SCALE

0 50 100ft
HORIZONTAL SCALE

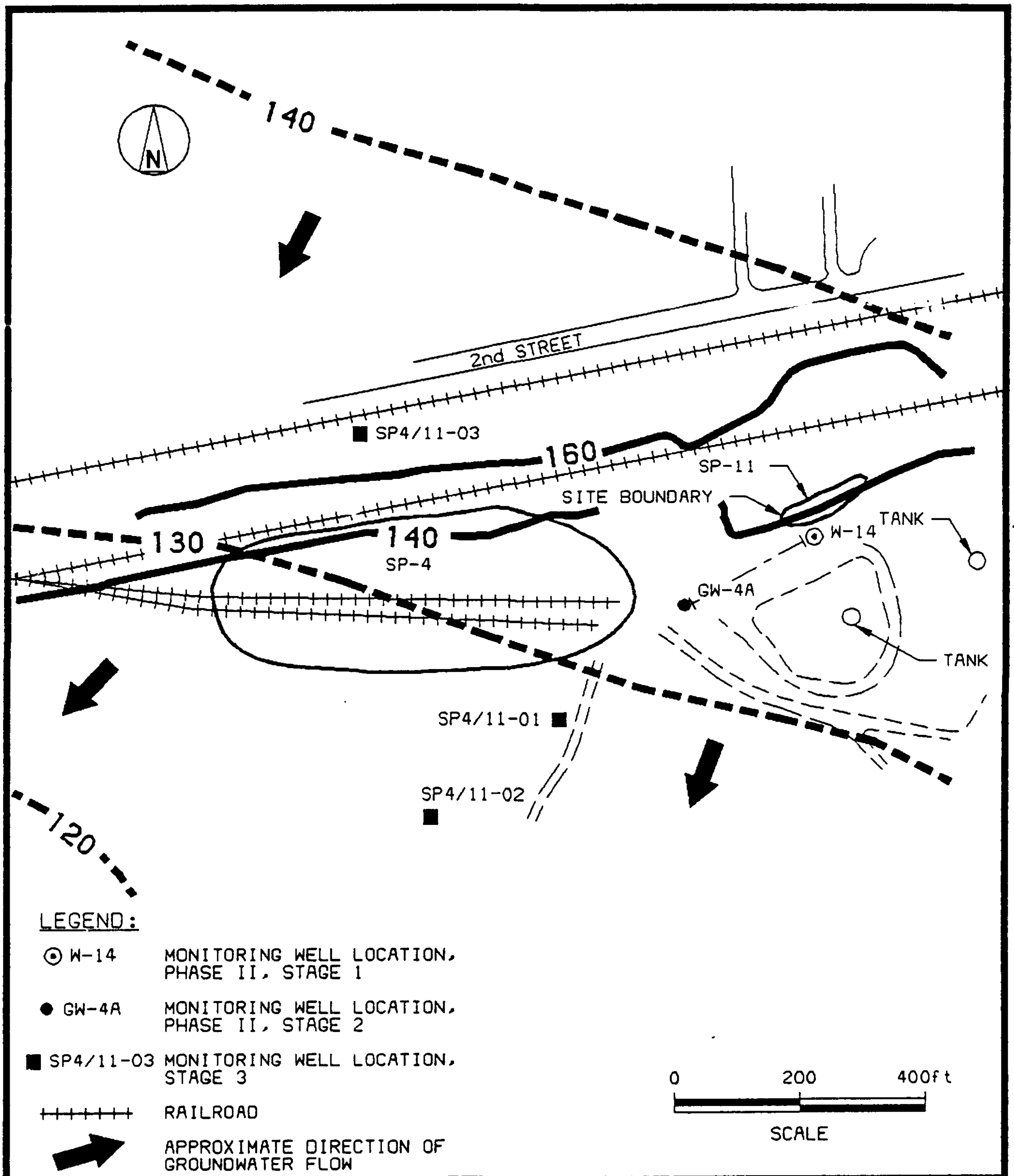
Notes:

1. Horizontal scale: 1 inch = 50 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Geologic cross section shown on Figure 4.2.14.3

GEOLOGIC CROSS SECTION
SITE SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.14.2



HYDROGEOLOGIC MAP

SITE SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.14.3

4.2.14.1.3.1 Field Analytical Results and Observations

No borings were drilled at Site SP-11 and no liquid product was observed seeping from the ground. Results of a soil gas survey conducted at the site are presented on Figure 4.2.14.4 and in Table 4.2.14.1. Isoconcentration contours have been drawn based on the findings of the field analysis.

Field parameters measured at Site SP-11 during groundwater sampling are provided on Table 4.2.14.2.

4.2.14.1.3.2 Laboratory Analytical Results

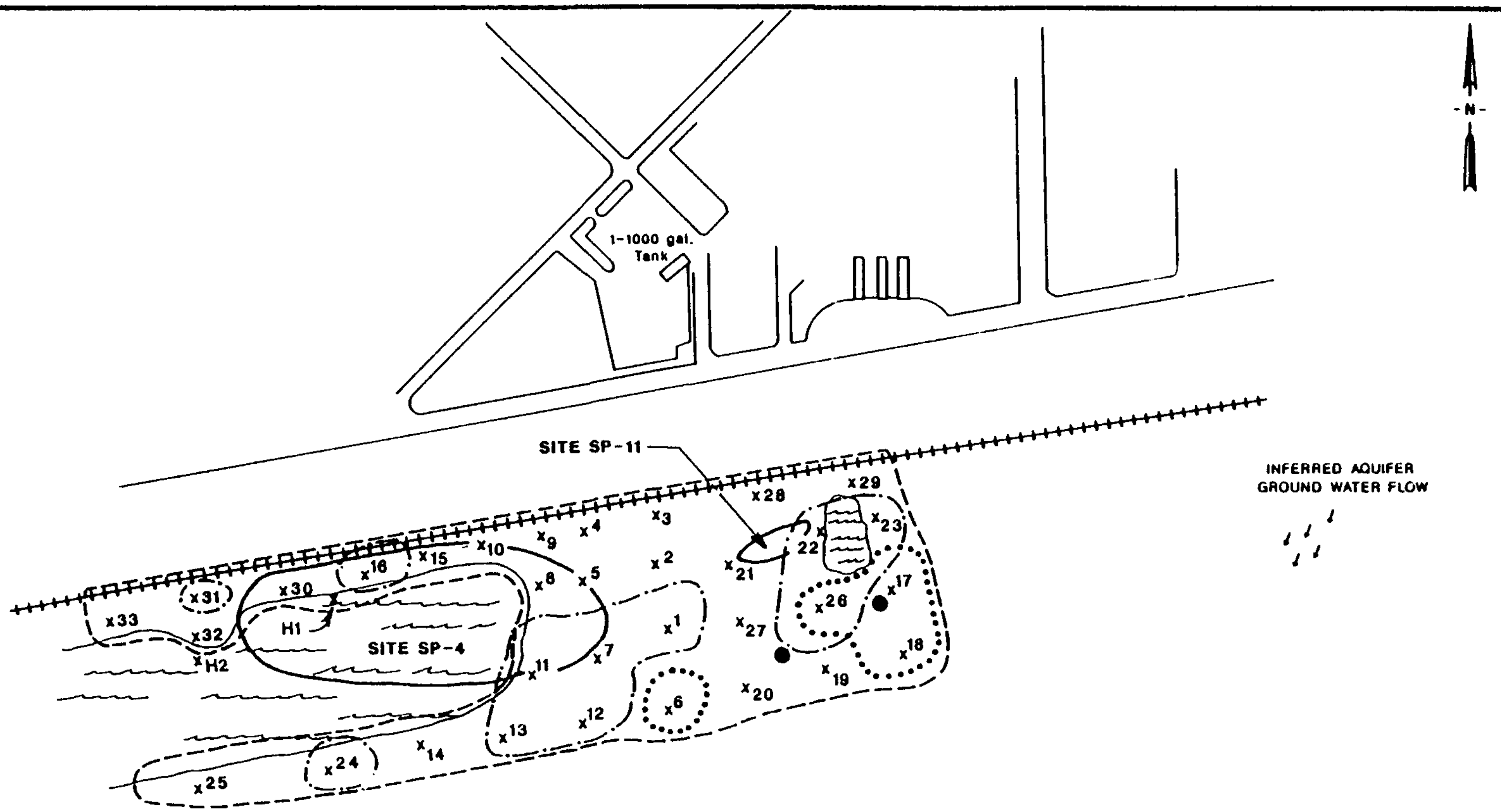
The laboratory analytical program for Site SP-11 is presented in Table 4.2.14.3, and the sample plan for the base-wide field investigation program is included in Appendix B. Major petroleum-based contaminants identified from the laboratory analysis of samples collected at Site SP-11 are plotted on Figures 4.2.14.5 and 4.2.14.6. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding test boring. Isoconcentration lines were not drawn due to the few points having detectable contamination for each analyte.

4.2.14.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site SP-11 are presented in Table 4.2.14.4.

4.2.14.1.5 Discussion of Analytical Data

Benzene (16 ug/L) was detected in a water sample from well GW-4A. Petroleum hydrocarbons were detected at concentrations of 1.0 mg/L and 3.0 mg/L in wells W-14 and GW-4A, respectively. No other purgeable aromatics were detected.



Legend:

Detectable Unidentified Organic Contamination

Detectable BTX Contamination

>10ppm BTX Contamination

Surface Water

Tanks

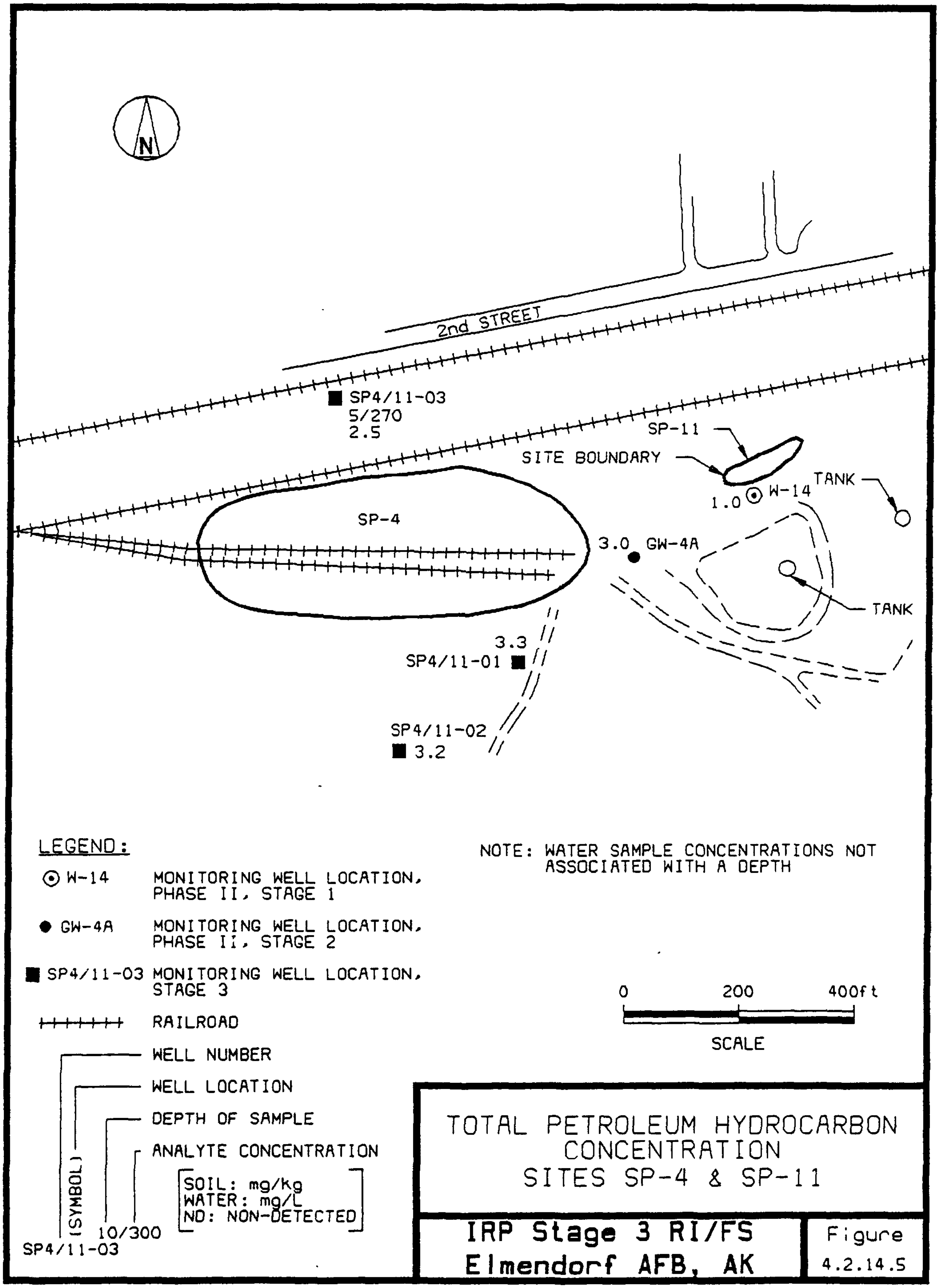
x_2 Probe Location

xH1 Headspace, Surface Water

SOIL GAS SURVEY
LOCATIONS AND RESULTS
SITES SP-4 & SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

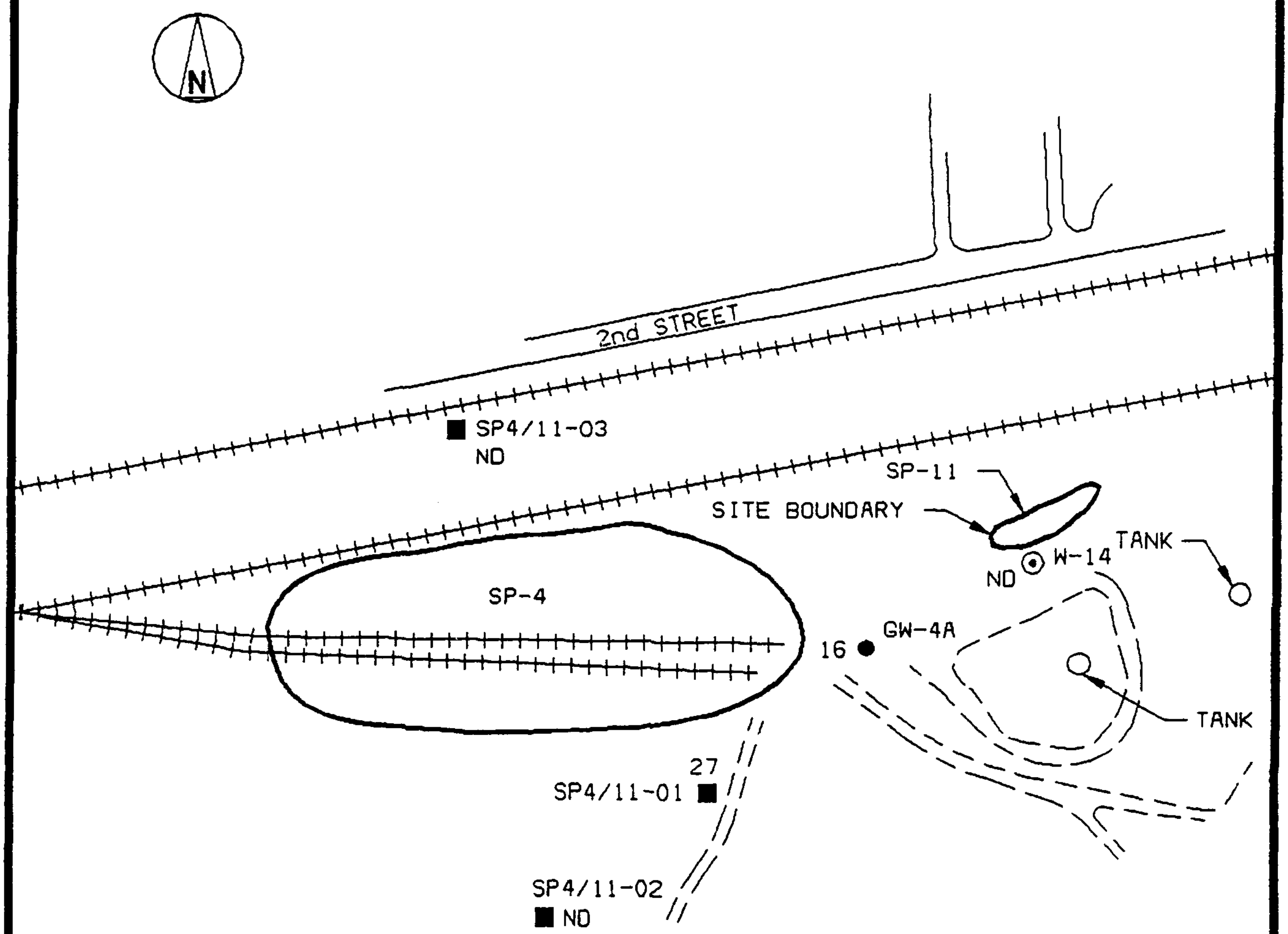
Figure 4.2.14.4



TOTAL PETROLEUM HYDROCARBON CONCENTRATION
SITES SP-4 & SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.14.5



LEGEND:

W-14 MONITORING WELL LOCATION, PHASE II, STAGE 1

GW-4A MONITORING WELL LOCATION, PHASE II, STAGE 2

SP4/11-03 MONITORING WELL LOCATION, STAGE 3

RAILROAD

WELL NUMBER

WELL LOCATION

DEPTH OF SAMPLE

ANALYTE CONCENTRATION

SOIL: mg/kg
WATER: mg/L
ND: NON-DETECTED

(SYMBOL)
10/300
SP4/11-03

NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

0 200 400ft

SCALE

BENZENE CONCENTRATION

SITES SP-4 & SP-11

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.14.6

Table 4.2.14.1 Summary of Gas Chromatograph Analyses of Soil Gas Samples from Sites SP-4 and SP-11.

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)	Comments
1	10	-	1.36	.58	.09	Unidentified Organics at 1.1 RT
2	10	-	.39	.03	-	
3	5	-	1.54	TR	.29	
	10	-	1.46	TR	-	
4	5	-	.68	.40	.16	
	10	-	.01	-	-	
5	10	TR	1.17	.03	TR	
6	5	6.15	TR	15.97	-	Water to surface; diesel; possibly with JP4
7	5	-	1.27	8.43	-	
	10	-	1.19	1.59	.42	
8	5	-	1.33	-	-	
	10	-	1.95	-	-	
9	8.5	-	.63	-	-	
10	8.5	-	.80	.19	.17	
11	5	-	.79	9.53	.65	
12	5	-	1.70	2.57	.11	
	10	.13	.79	.77	.20	
13	5	-	1.17	1.08	.53	
14	10	-	4.14	8.89	-	
15	6.5	-	1.76	-	-	
16	10	-	1.02	.82	.45	
17	10	-	1.67	9.80	-	
18	10	-	19	-	-	
19	10	-	-	1.41	TR	
20	10	-	.22	.35	-	
21	10	-	1.58	-	-	
22	10	-	2.99	-	.44	
23	10	-	1.42	TR	.16	
24	10	-	1.62	3.49	.09	
25	10	.34	2.27	.40	-	
26	10	-	2.85	8.89	.12	
27	10	-	1.90	2.9	-	
28	8	-	TR	TR	-	
29	10	-	.09	-	TR	
30	10	TR	.22	TR	TR	
31	10	-	TR	-	.94	
32	10	2.27	1613	-	-	Diesel; possibly with JP4
33	10	-	TR	5.63	-	
H1	headspace	-	2.46	-	-	Water sample with visible sheen
H2	headspace	-	.786	-	-	

Note: Unidentified organics are reported in benzene equivalent ppm.
TR - Trace
RT - Retention Time

Table 4.2.14.2 Field Parameters Site SP-11

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
W-14	8/12/88	5.7	215	7.20	133	No odor or sheen
GW-4A	8/12/88	8.0	265	6.96	165	Slight POL odor, sheen

Table 4.2.14.3 Requested Analyses for Laboratory Samples at Site SP-11

WATER

Test Number	Analysis
418.1	Petroleum Hydrocarbons
602	Purgeable Aromatics

Table 4.2.14.4

Analytical Results - Site SP-11

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-14 0687-NG-090 001229-0001	GW-88-0001	W-14 GW840264	W-14 W-1/16	W-14 W-14-2	W-14 W-14-3	W-14 W-14/41	GW-4A 0687-NG-091 001229-0002	GW-88-0001	GW-4A GW-4A/13	GW-4A GW-4A/14	GW-4A GW-4A/8	G-1 G-1	G-2 G-2
Benzene	EPA 602	ug/L	5.0								16.						
DIBROMOCHLOROMETHANE	601	ug/L													1.6		
MOISTURE	GRAV.	%						15	11							29	66
OIL & GREASE	413.2	mg/L				1.7		14								3000	159
TDS	160.1	mg/L	500			200				220			220				
TETRACHLOROETHENE	601	ug/L	5.0				0.53								0.46		
TOX	9020	ug/L				48											
TRANS-1,2-DICHLOROETHENE	601	ug/L	70												2.4		
TRICHLOROETHENE (TCE)	601	ug/L	5.0												3		
TRICHLOROFLUOROMETHANE	601	ug/L													0.49		
Total Petroleum Hydrocarbons	EPA 418.1	mg/L		1.0							3.0			19			

4.2.14.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site SP-11 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.14.2.1 Loss of Samples

No water samples collected for laboratory analysis were lost from Site SP-11.

4.2.14.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in samples from the site.

4.2.14.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Two water samples were collected; one from each of the existing wells. No out-of-control conditions occurred during sampling operations at the site.

4.2.14.3 Significance of Findings

Analytical methods detected organic compounds and petroleum hydrocarbons in oil and water samples from Site SP-11. Benzene was

detected in water from well GW-4A at SP-11 at a concentration of 16 ug/L which exceeds the State of Alaska Primary Drinking Water Standard of 5 ug/L. The water sample from this well also had a petroleum odor and sheen, thereby exceeding State of Alaska Drinking Water Standards for petroleum hydrocarbons.

Water samples collected in 1986 from well GW-4A contained dibromochloromethane, tetrachloroethane, trichloroethene and trichlorofluoromethane at levels above detection limits (Dames and Moore 1987). State of Alaska standards for tetrachloroethene, trichloroethene, and trichlorofluoromethane were exceeded in this well. Well W-14, also sampled in 1986, contained only tetrachloroethene at a level above State of Alaska standards. Well W-14 was not contaminated above detection limits for these compounds in 1988 samples.

The source of petroleum hydrocarbons and benezene, in the water at this site is JP-4 that leaked from a crack in an underground pipe. (Engineering-Science, 1983). The specific quantity of jet fuel spilled was never recorded.

Pathways of exposure are contact with and ingestion or uptake of contaminated ground or surface water. Receptors of the contamination are humans, wildlife, fish and plants.

4.2.14.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. A soil gas survey at Site SP-11 showed detectable BTX contamination throughout the area south of the railroad (Figure 4.2.14.4). Several areas of unidentified organics ontamination were detected during the survey. Existing wells W-14 and GW-4A were located in or near these areas. Petroleum hydrocarbons and/or volatile organics were present in water. General concentration lines have been constructed for the soil gas data, but there is

insufficient data from other sources to allow three-dimensional temporal or higher-definition spatial mapping.

4.2.14.3.2 Contaminant Migration

Contaminants are probably migrating in the groundwater as evidenced by petroleum hydrocarbons in well GW-4A. Although the well is downgradient from the reported spill site, the highest concentration of petroleum hydrocarbons was found in the most downgradient well, well GW-4A. Benzene was also detected in a water sample from well GW-4A. Well SP4-01 is situated downgradient from well GW-4A. It was sampled as part of the investigation for Site SP-4 (Section 4.2.12). Well SP4-01 1 at Site SP-4 also contained benzene, although at a concentration greater than that detected in GW-4A. It appears that the contamination has migrated downgradient from this spill site.

4.2.14.3.2.1 Potential for Offsite and Off-Base Migration

Offsite migration of contamination has occurred at Site SP-11 as evidenced by contamination in the downgradient well GW-4A. This contamination extends further downgradient and offsite to well SP4-01. The soil gas survey detected contamination encompassing about 16 acres, covering areas to the north, south, east and west of the presumed spill site. However, contamination to the west may have originated due to a spill at Site SP-4, located to the east of Site SP-11.

Should contamination from Site SP-11 reach Ship Creek, less than 500 feet to the southwest, it would be carried off base in the creek water.

4.2.14.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site inferred that the direction of groundwater flow is to the south-southwest with a gradient of about 60 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of the migration rate of the dissolved chemicals.

4.2.14.3.2.3 Time of Travel to Receptors

The primary receptors at present are humans, wildlife, fish and plants. Primary pathways are ingestion of contaminated ground and surface water and handling of contaminated soil.

A secondary exposure route would be the ingestion of contaminated plants or fish. Ship Creek is located about 500 feet southwest of Site SP-11. Hydraulic conductivity values have not been established; thus, time of travel to the creek cannot be estimated. Any contamination reaching the creek is expected to become highly diluted. A former cooling water pond is situated about 200 feet southeast of the site. Contamination may reach the pond even though it is not directly downgradient. It is suspected that the pond has an outlet to Ship Creek.

An active drinking water well, base well 52, is about 3000 feet downgradient of the site at building 23-100. This well was sampled as part of this study (Section 4.2.24). Time of travel to the well has not been determined because hydraulic conductivity at the site has not been established.

Base well 52 is an artesian well, drilled to a depth of 166 feet (Phase II, Stage 2 Report, Dames and Moore 1988). The water from the well is contained inside a casing as it flows through the zone of probable contamination detected at Site SP-11, and is unlikely to be affected by impacts from the site.

4.2.14.3.2.4 Expected Spatial and Temporal Variations in Concentration

A soil gas survey detected contamination by BTX and solvents encompassing an area of about 16 acres. The actual spill site is located in the northeast corner of the area investigated by the soil gas survey; therefore, it can be assumed that some of this contamination is upgradient of the spill. Contamination to the west and northwest of Site SP-11 may be attributed to a spill that occurred at Site SP-4.

The spatial extent of contamination in groundwater reaches at least to well SP4-01 which is about 400 feet downgradient of the presumed spill site. Well SP4-02 is situated about 900 feet southwest of the spill at Site SP-11. This well was contaminated with petroleum hydrocarbons, but the contamination may originate at both Sites SP-4 and SP-11.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of the contaminants is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.14.3.3 Baseline Risk Assessment

The contamination is evaluated in relation to exposure routes, receptors, and health effects in the following sections.

4.2.14.3.3.1 Waste Characterization

The primary wastes at the site are petroleum hydrocarbons and benzene. Total petroleum hydrocarbons were detected in water samples from both wells at Site SP-11. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects. Benzene was detected in water from 1 well. This volatile organic is a known human carcinogen.

4.2.14.3.3.2 Source and Release Characterization

Petroleum hydrocarbons and benzene were released to the environment as the result of a JP-4 leak in an underground pipe. The specific amount of fuel spilled was never recorded. The pipe was repaired, but recovery activities did not occur (Engineering-Science, 1983).

4.2.14.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons and benzene released to the environment at Site SP-11 includes long-term natural degradation, dispersion of the contaminants through runoff, or uptake by living organisms. Volatilization is another possible fate for benzene since its vapor pressure (v.p.) is greater than 1 mm of Hg (v.p. 100 mm at 26 C).

Dissolved contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration with the groundwater through the process of advection. Additional transport can occur in the form of surface runoff or release of vapor to the atmosphere. Contaminated water from the site can be transported through human intervention.

4.2.14.3.3.4 Exposure Pathways

At present, the exposure pathway for humans, fish and wildlife is contact with or ingestion of contaminated ground or surface water, fish or plants.

4.2.14.3.3.5 Identification of Receptors

Receptors are humans, fish, wildlife, and plants. Human receptors include anyone drinking from base well 52, or ingesting water and fish from Ship Creek or the cooling pond. Plants in the contaminated area are less likely to become contaminated since surface and near-surface soils have not been shown to be contaminated. However, some of the larger trees in the vicinity may reach to groundwater at 20 to 30 feet.

4.2.14.3.3.6 Threat to Human Health

A possible threat to human health is the drinking of water from base well 52. Base well 52 was sampled as part of this investigation (Section 4.2.24). The sample contained petroleum hydrocarbons, but no volatile organics. Due to the low toxicity of petroleum hydrocarbons, and the design of the well, any threat to human health from drinking water from base well 52 is assessed as low.

Another threat to human health is the drinking of Ship Creek water or cooling pond water, or the ingestion of fish from Ship Creek or the cooling pond. As part of this study, water and sediment were collected and analyzed from a point on Ship Creek, southwest and downgradient from Site SP-11 and downstream of the cooling pond (Section 4.2.23). The samples did not contain petroleum hydrocarbons or volatile organic compounds above method detection limits. The threat to human health from exposure to Ship Creek and cooling pond water is minimal to non-existent.

4.2.14.3.3.7 Carcinogenic Risks

Benzene was detected in a water sample from well GW-4A. EPA lists benzene as a Group A human carcinogen.

4.2.14.3.3.8 Threat to Wildlife

Threat to wildlife is possible through ingestion of contaminated surface waters. Ship Creek constitutes the nearest downgradient surface water body. The threat is minimal to non-existent due to the high dilution rate of creek water and the fact that this study found creek water and sediments to be uncontaminated (Section 4.2.23).

4.2.14.4 Prioritization of Sites for Remedial Alternatives

Concentrations of benzene in groundwater at this site exceeded State of Alaska standards. Receptors are present, but distant. Site SP-11 should be combined with the adjacent Site SP-4 for further site characterization, data analysis and reporting purposes. Site SP-11 is recommended for medium-priority classification. A total of 5 borings are proposed for Site SP-4/11. Three of the borings should be drilled to 10 feet to determine the spatial extent of the contamination in the soil. The 2 other borings should be drilled to the shallow groundwater and completed as monitoring wells. Groundwater samples should also be obtained from the drinking water well (base well 52) and surface water samples should be obtained from the ponds located on the site. Soil samples from the 5 borings should be analyzed for TPH and VOCs. Both the proposed and previously installed wells should be sampled and analyzed for petroleum hydrocarbons, purgeable aromatics and purgeable halocarbons.

4.2.15 <u>Discussion of Results for Site SP-12, JP-4 Fuel Line Leak</u>

An underground fuel line leak of about 1,000 gallons of JP-4 reportedly occurred at Site SP-12 (Figure 4.2.15.1) in 1971 (Engineering Science 1983). Most of the spilled fuel was recovered, and the contaminated soil was removed (Dames and Moore 1987).

4.2.15.1 Presentation of Results for Site SP-12

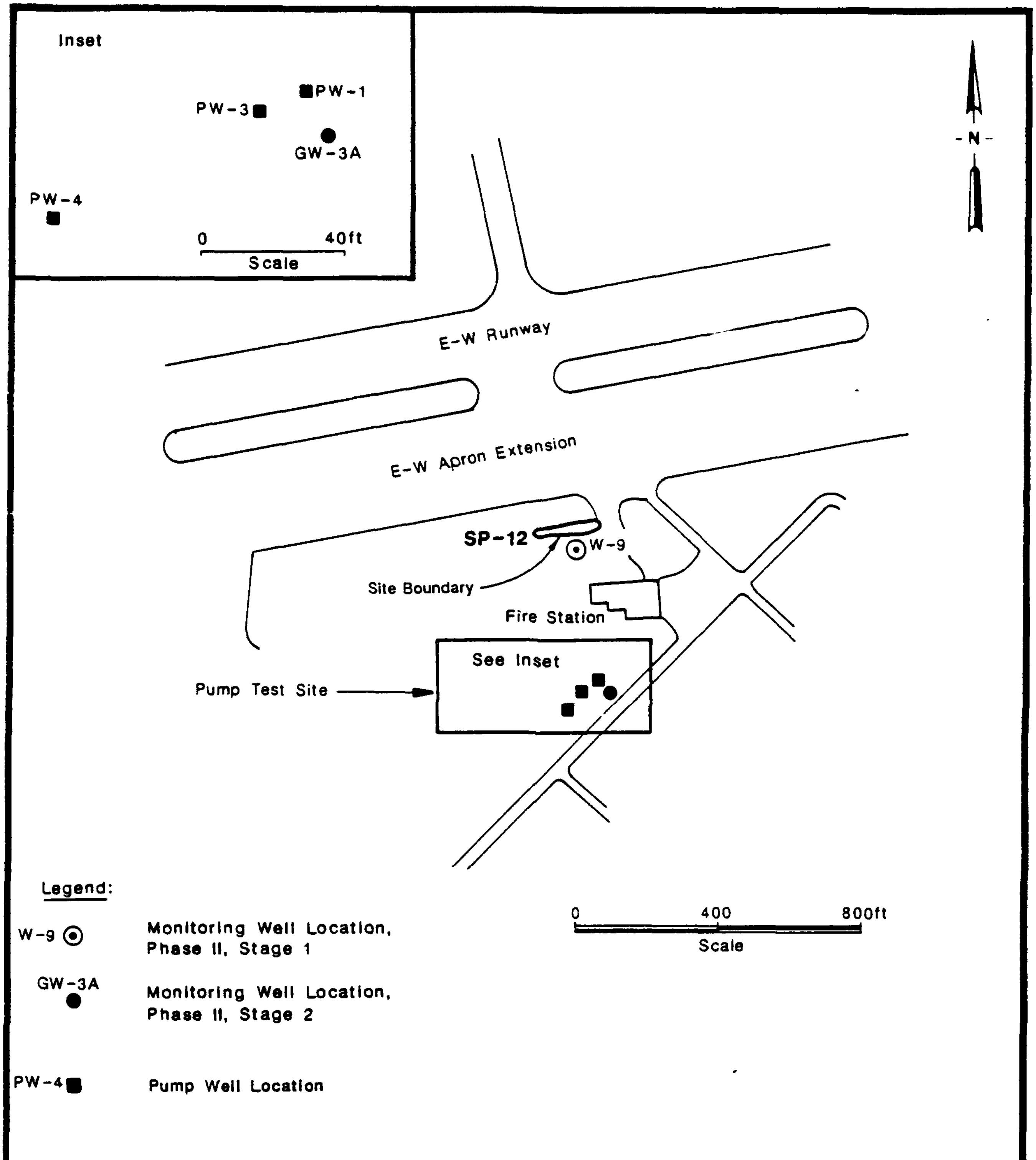
Results of the geologic and hydrogeologic investigations are presented below. Analytical results are tabulated and presented on the site location maps.

4.2.15.1.1 Site Geology

Site SP-12 is located at an elevation of about 175 feet on flat terrain. The site is underlain by late-Quaternary outwash deposits consisting chiefly of coarse sands and gravels. Below these outwash deposits at a depth of about 75 feet are the silt and clay-rich layers of the Bootlegger Cove Formation. A schematic geologic cross section of the site is presented in Figure 4.2.15.2.

4.2.15.1.2 Site Hydrogeology

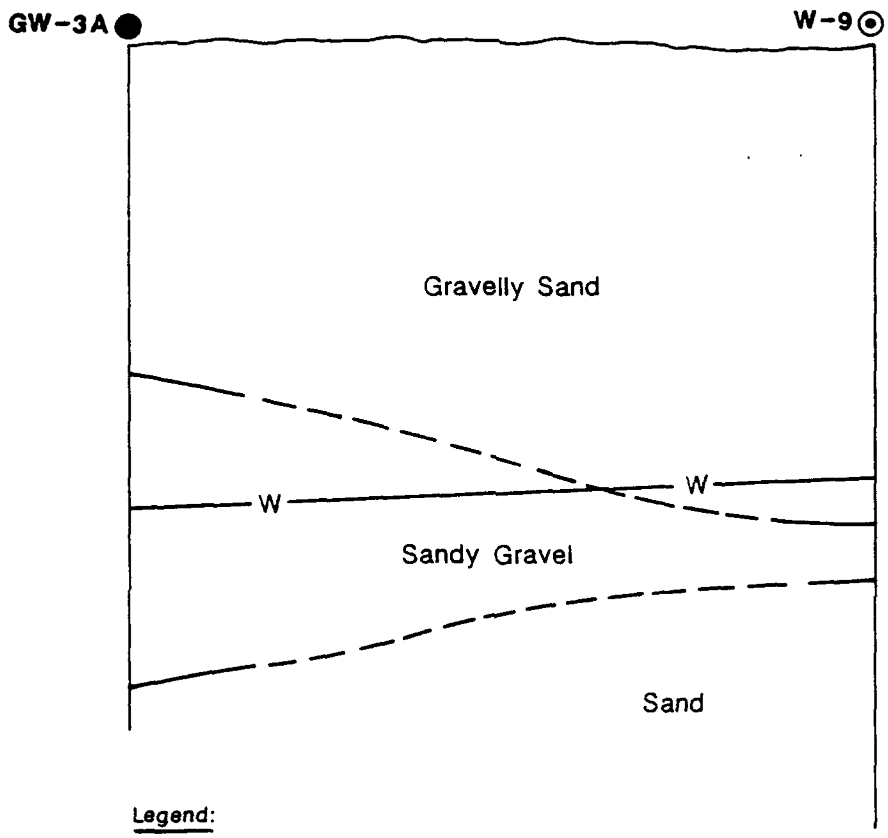
Site SP-12 is underlain by sands and gravels with a water table depth of approximately 20 to 25 feet. The direction of groundwater flow is based on comparison of regional trends and water level measurements at 5 wells at the site. The groundwater flow direction is southwest with a gradient of approximately 25 feet per mile (Figure 4.2.15.3). Hydraulic conductivity at this site has not been determined.



LOCATION MAP
SITE SP-12

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.15.1

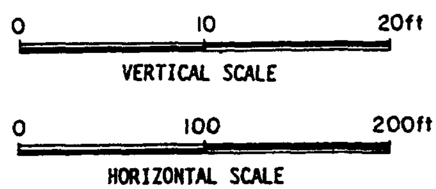


Legend:

- GW-3A ● Monitoring Well, Phase II, Stage II
- W-9 ⊙ Monitoring Well, Phase II, Stage I
- —W— Projected Water Table
- — — — Geologic Contact, Dashed Where Inferred

Notes:

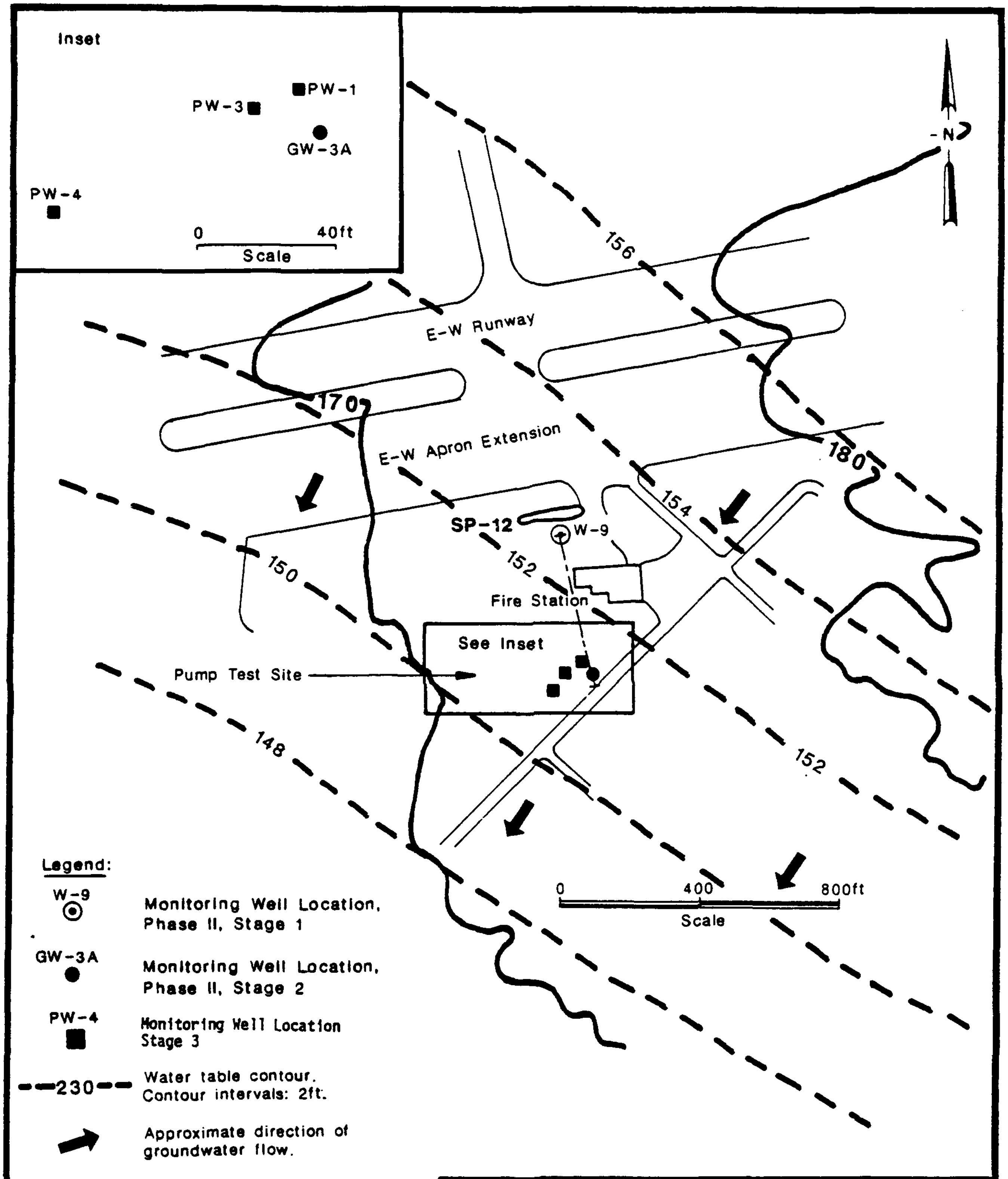
1. Horizontal scale: 1 inch = 100 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Geologic cross section shown on Figure 4.2.15.3



GEOLOGIC CROSS SECTION
SITE SP-12

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.15.2



HYDROGEOLOGIC MAP
SITE SP-12

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.15.3

4.2.15.1.3 Analytical Results

The following sections discuss field analytical results and observations and laboratory analytical results.

4.2.15.1.3.1 Field Analytical Results and Observations

Borings and subsurface investigations were not conducted at Site SP-12 during this field investigation program, although groundwater samples were collected from 2 existing monitoring wells. The site is vegetated by healthy grass which is periodically mowed.

Field parameters measured at Site SP-12 during groundwater sampling are provided on Table 4.2.15.1.

4.2.15.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site SP-12 is presented on Table 4.2.15.2, and the sample plan for the base-wide field investigation program is included in Appendix B. Only total petroleum hydrocarbons were identified from the laboratory analysis of samples collected at Site SP-12. The total petroleum hydrocarbon concentrations are plotted next to the corresponding well on Figure 4.2.15.4. Isoconcentration lines were not drawn due to few points having detectable contamination for total petroleum hydrocarbon.

4.2.15.1.4 Analytical Results Table

All of the laboratory analytical results for Site SP-12 are presented on Table 4.2.15.3.

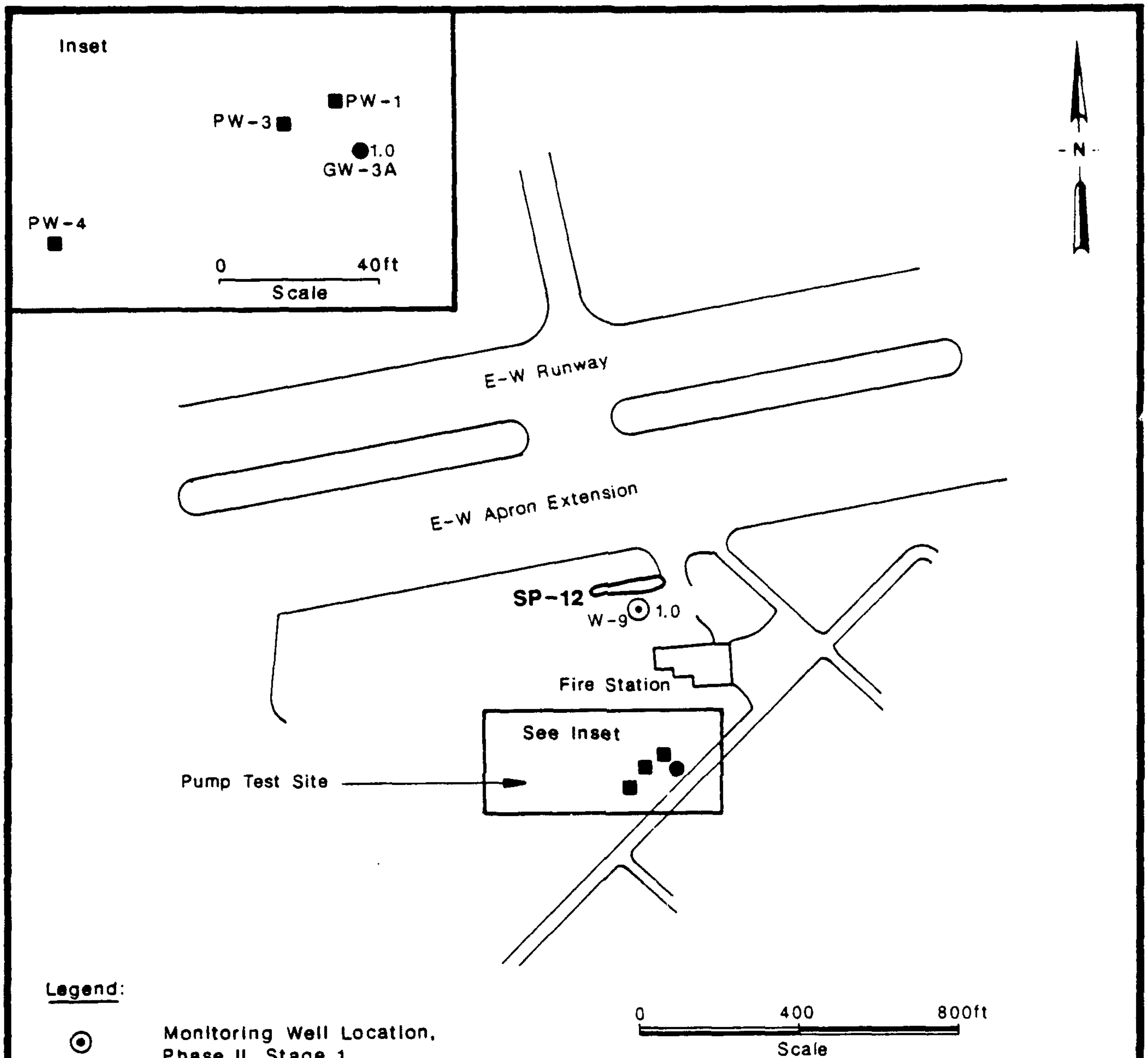
Table 4.2.15.1 Field Parameters Site SP-12

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
W-9	8/12/88	7.5	500	7.21	293	No odor or sheen
GW-3A	8/12/88	7.5	445	7.26	228	No odor or sheen

Table 4.2.15.2 Requested Laboratory Analyses for Samples from Site SP-12

WATER

Test Number	Analysis
418.1	Petroleum Hydrocarbons
602	Purgeable Aromatics



Legend:

Monitoring Well Location, Phase II, Stage 1

Monitoring Well Location, Phase II, Stage 2

PW-1 Monitoring Well Location Stage 3

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

Water: mg/L
ND: Non-Detected
Soil: mg/kg

PW-1 (Symbol) 10/300

Note: Water sample concentrations not associated with a depth.

TOTAL PETROLEUM HYDROCARBON CONCENTRATION
SITE SP-12

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.15.4

Table 4.2.15.3

Analytical Results - Site SP-12

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-9 0687-NG-092 GN-88-0001 001229-0008	W-9 GN840279	W-9 25' W-9-7	W-9 35' W-9-9	W-9 W-9/3	GW-3A 0687-NG-093 GN-88-0001 001229-0009	GW-3A GW-3A/1	GW-3A GW-3A/2
MOISTURE	GRAV.	%				11	12				
OIL & GREASE	413.2	mg/L			1	13	20				
TDS	160.1	mg/L	500					420		400	
Total Petroleum Hydrocarbons	EPA 418.1	mg/L		1.0					1.0		0.1

4.2.15.1.5 Discussion of Analytical Data

Petroleum hydrocarbons were detected in 2 water samples from Site SP-12. A total petroleum hydrocarbon concentration of 1.0 mg/L was detected in water from both wells GW-3A and W-9.

4.2.15.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site SP-12 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.15.2.1 Loss of Samples

No water samples collected for laboratory analysis were lost from Site SP-12.

4.2.15.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in samples from the site.

4.2.15.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Two water samples were collected; 1 from each of 2 previously installed wells. Well W-9 was not secured; the metal outer cap was

present, but the padlock was missing. The well also showed some damage, possibly from snow removal equipment. Holding times were exceeded for both total petroleum hydrocarbon tests (418.1).

4.2.15.3 Significance of Findings

Analytical methods detected contamination by petroleum hydrocarbons in water samples from Site SP-12. Both wells W-9 and GW-3A contained total petroleum hydrocarbons at a concentration of 1.0 mg/L. There is no State of Alaska standard for total petroleum hydrocarbons other than the presence of odor or taste. No sheen or petroleum odors were detected during sampling of the wells. Water samples from the 2 wells at Site SP-12 were also tested for purgeable aromatics; however, no purgeable organics were detected. Water samples were collected from both wells in 1986 (Dames and Moore 1987). At that time, petroleum hydrocarbons were not detected in a sample from well GW-3A, but were detected at a concentration of 1.1 mg/L in well W-9.

The source of petroleum hydrocarbons in the water is probably a JP-4 fuel line leak of about 1,000 gallons (Engineering Science 1983). Pathways of exposure are ingestion, handling, or uptake of the groundwater by humans, wildlife or plants.

4.2.15.3.1 Zones of Contamination

Petroleum hydrocarbons were detected in water collected from wells W-9 and GW-3A at Site SP-12. However, petroleum odors and/or sheens were not observed during sampling. No other organic contaminants were detected.

4.2.15.3.2 Contamination Migration

The primary migration medium is groundwater. The direction of groundwater flow at Site SP-12 is toward the southwest. Both wells

are located outside of the spill site boundary. Well W-9 is situated directly south of the spill and is downgradient. Well GW-3A is situated to the south-southeast of well W-9 and the spill site and cannot be considered directly downgradient. Both wells contained equal concentrations of total petroleum hydrocarbons. This is evidence that a slight amount of contaminant migration or diffusion may be occurring at Site SP-12.

4.2.15.3.2.1 Potential for Offsite and Off-Base Migration

Offsite migration of petroleum hydrocarbons is occurring at Site SP-12. Contamination was detected in 2 offsite wells, one of which is directly downgradient of the site. However, contamination was within State of Alaska Primary Drinking Water Standards.

The potential for off-Base migration of contaminants is unknown, but is expected to be limited. The direction of subsurface flow is to the southwest. The nearest base boundary in that direction is about 6500 feet distant.

4.2.15.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site identified a groundwater flow gradient of 25 feet per mile. The horizontal hydraulic conductivity has not been determined.

4.2.15.3.2.3 Time of Travel to Receptors

Primary receptors are humans, plants, and wildlife. The primary pathway is through contaminated groundwater. An active drinking water well (base well 16) is located about 2200 feet south-southwest of the site and may be hydraulically downgradient. Groundwater migration rates have not been established for this site; thus, time of travel to

this well cannot be determined. However, base well 16 is an artesian well, drilled to a depth of 228 feet (Phase II, Stage 2 Report, Dames and Moore 1987). The water from this well is contained in a casing as it flows through the zone of potential contamination detected at Site SP-12. It is unlikely that this well has been contaminated by sources at Site SP-12.

Ship Creek is located about 5000 feet downgradient from the site. Time of travel to this receptor cannot be determined because groundwater migration rates have not been established. Any contamination reaching the creek is expected to become highly diluted within the creek water.

4.2.15.3.2.4 Applicability of Solute Transport Models

Since levels of contamination by petroleum hydrocarbons at Site SP-12 were within compliance, solute transport models are not necessary. The potential risk of contamination for downgradient water supplies and surface water is slight.

4.2.15.3.2.5 Expected Spatial and Temporal Variations in Concentration

Groundwater flow is primarily to the southwest of Site SP-12. The spatial extent of contamination past the site boundaries reaches at least to well W-9, which is about 40 feet downgradient from what is estimated to be the spill location. Well GW-3A, though not directly downgradient of the site, was also contaminated. The contamination may extend to the southwest past these wells. Any petroleum-based contamination detected in water from base well 16 may have its source at Site SP-12.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation.

4.2.15.3.3 Baseline Risk Assessment

The contamination in relation to exposure routes, receptors, and health effects are evaluated in the following sections.

4.2.15.3.3.1 Waste Characterization

The primary waste at this site is petroleum hydrocarbons. In general, these compounds are not considered to be highly toxic, but can have anesthetic effects at high concentrations.

4.2.15.3.3.2 Source and Release Characterization

The source of petroleum hydrocarbons at Site SP-12 is probably JP-4 fuel spilled during a pipeline leak occurring in 1971 (Engineering Science, 1983). The compounds were released to the environment through percolation into the soil, subsequently reaching the water table. At the saturated groundwater zone, the chemicals are able to float on the water and migrate along the hydraulic gradient.

The volume of contamination released by this spill was recorded as 1,000 gallons. Most of the spilled fuel was recovered or removed with the surface soil layers (Dames and Moore, 1987).

4.2.15.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons released to the environment at Site SP-12 includes long-term degradation, mixing and dilution in the saturated zone, and/or uptake by living organisms.

4.2.15.3.3.4 Exposure Pathways

Exposure pathways are uptake of the groundwater by plants, and the ingestion of groundwater or contaminated plants by wildlife and humans.

4.2.15.3.3.5 Identification of Receptors

Receptors are humans, plants, fish and wildlife. Although not established as being impacted by Site SP-12 contamination, both well 16 and Ship Creek are possible recipients. Therefore receptors could potentially include anyone drinking from well number 16, or ingesting water or fish from Ship Creek. Plants are possible, but unlikely receptors due to the lack of large trees in the vicinity of the runway and the depth of groundwater (nearly 30 feet).

4.2.15.3.3.6 Threat to Human Health

A potential threat to human health is the drinking of water from Base well 16. Another potential threat to human health is the drinking of Ship Creek water, or the ingestion of fish from Ship Creek. As part of this study, water and sediments were collected and analyzed from points on Ship Creek, southwest and downgradient from Site SP-12 (Section 4.1.23). The samples did not contain petroleum hydrocarbons above method detection limits. The threat to human health from exposure to Ship Creek waters is minimal to non-existent.

4.2.15.3.3.7 Carcinogenic Risks

No carcinogenic compounds were detected in water samples from Site SP-12.

4.2.15.3.3.8 Threat to Wildlife

Threat to wildlife is possible through ingestion of contaminated surface water. Ship Creek constitutes the nearest body of surface water. The threat of contamination is minimal due to the distance of the site from Ship Creek (5000 feet), the high dilution rate of creek water, and the fact that this study found creek water and sediments to be uncontaminated (Section 4.2.23).

4.2.15.3.3.9 No Threat to Health

Groundwater samples collected in 1988 were not contaminated above State of Alaska primary standards for petroleum hydrocarbons. Petroleum hydrocarbons are environmentally persistent, but are not considered to be highly toxic. Receptors and pathways of exposure are present, but the duration and frequency of exposure is not expected to be sufficient to cause adverse health effects.

4.2.15.4 Prioritization of Sites for Remedial Alternatives

The site has been adequately characterized by the sampling of 2 monitoring wells. Groundwater samples from these wells were not contaminated at levels above primary State of Alaska standards. Release mechanisms and migration pathways have not been shown to be sufficient. Site SP-12 is assigned to no further action status. Further investigation is not needed at the site.

4.2.16 Discussion of Results for Site SP-13, Diesel Fuel Line Leak

Site SP-13 (Figure 4.2.16.1) is the location of a 1968 diesel fuel spill. Approximately 800 gallons of fuel seeped into the ground as a result of a pipeline leak. None of the fuel was recovered (Engineering-Science, 1983).

4.2.16.1 Presentation of Results for Site SP-13

Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site location maps.

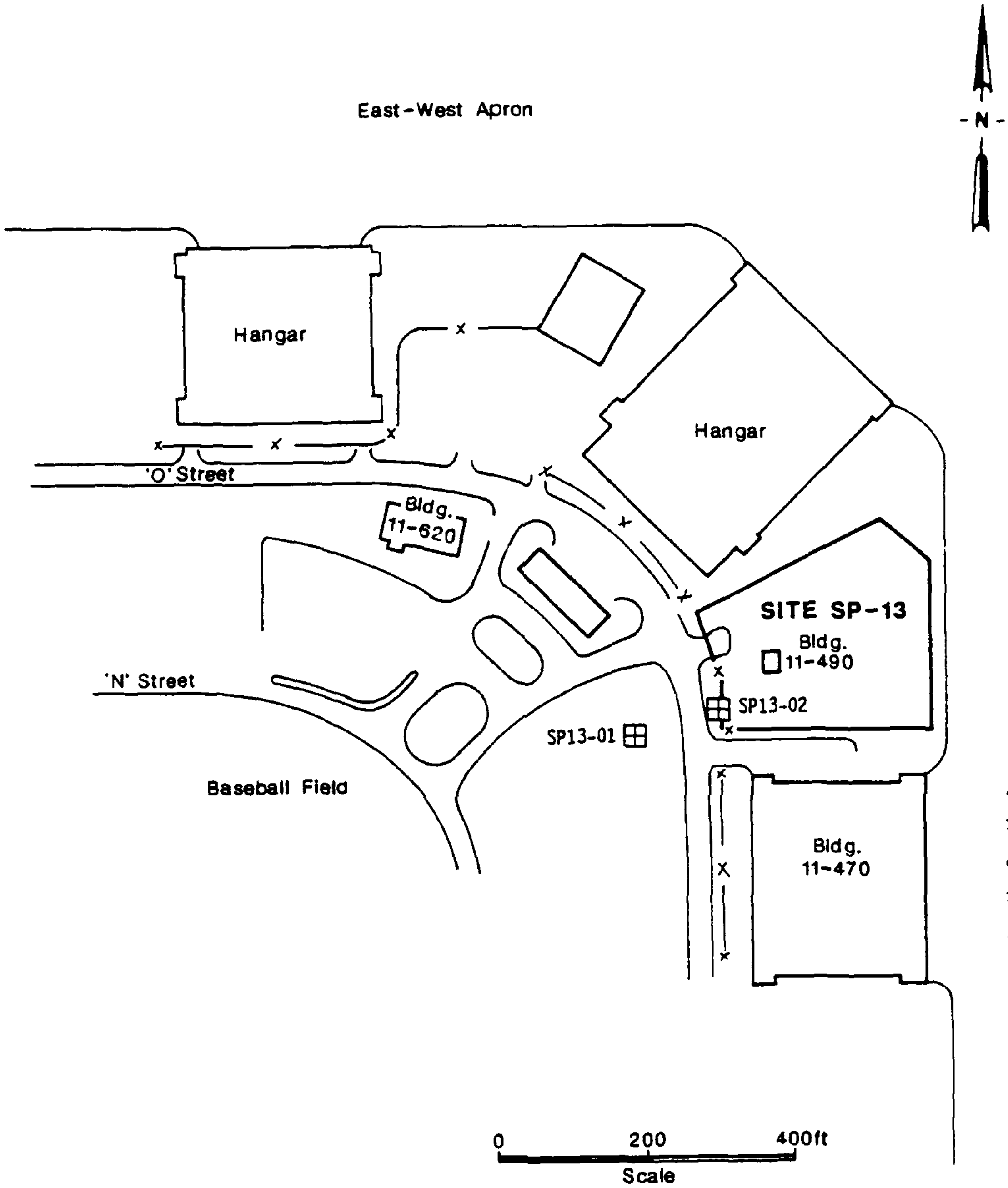
4.2.16.1.1 Site Geology

Site SP-13 is located at an elevation of about 185 feet on flat terrain underlain by late-Quaternary glacial outwash deposits consisting chiefly of coarse gravel and sand. Most of the area around the site is paved.

Two shallow borings dug in grassy areas at the margins of the site encountered coarse silty gravel to a depth of 5 feet. A schematic geologic cross section of the site area is presented in Figure 4.2.16.2.

4.2.16.1.2 Site Hydrogeology

Site SP-13 is underlain by sands and gravels with a water table depth of approximately 25 to 30 feet. The direction of groundwater flow is based on a comparison of regional groundwater trends (Figure 4.2.16.3). The direction of groundwater flow is southwest with a gradient of approximately 15 feet per mile. Hydraulic conductivity at this site has not been determined.



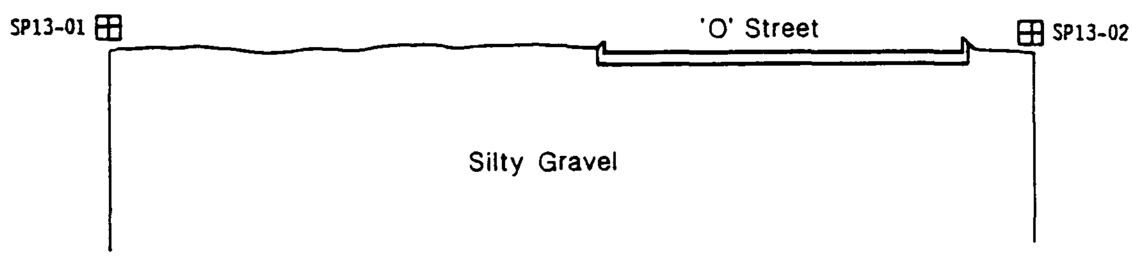
Legend:

SP13-01 ⊞ Stage 3 Borehole

LOCATION MAP
SITE SP-13

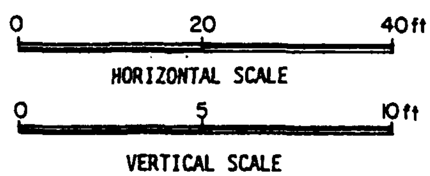
IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.16.1



Legend:

SP13-01 ⊞ Stage 3 Borehole

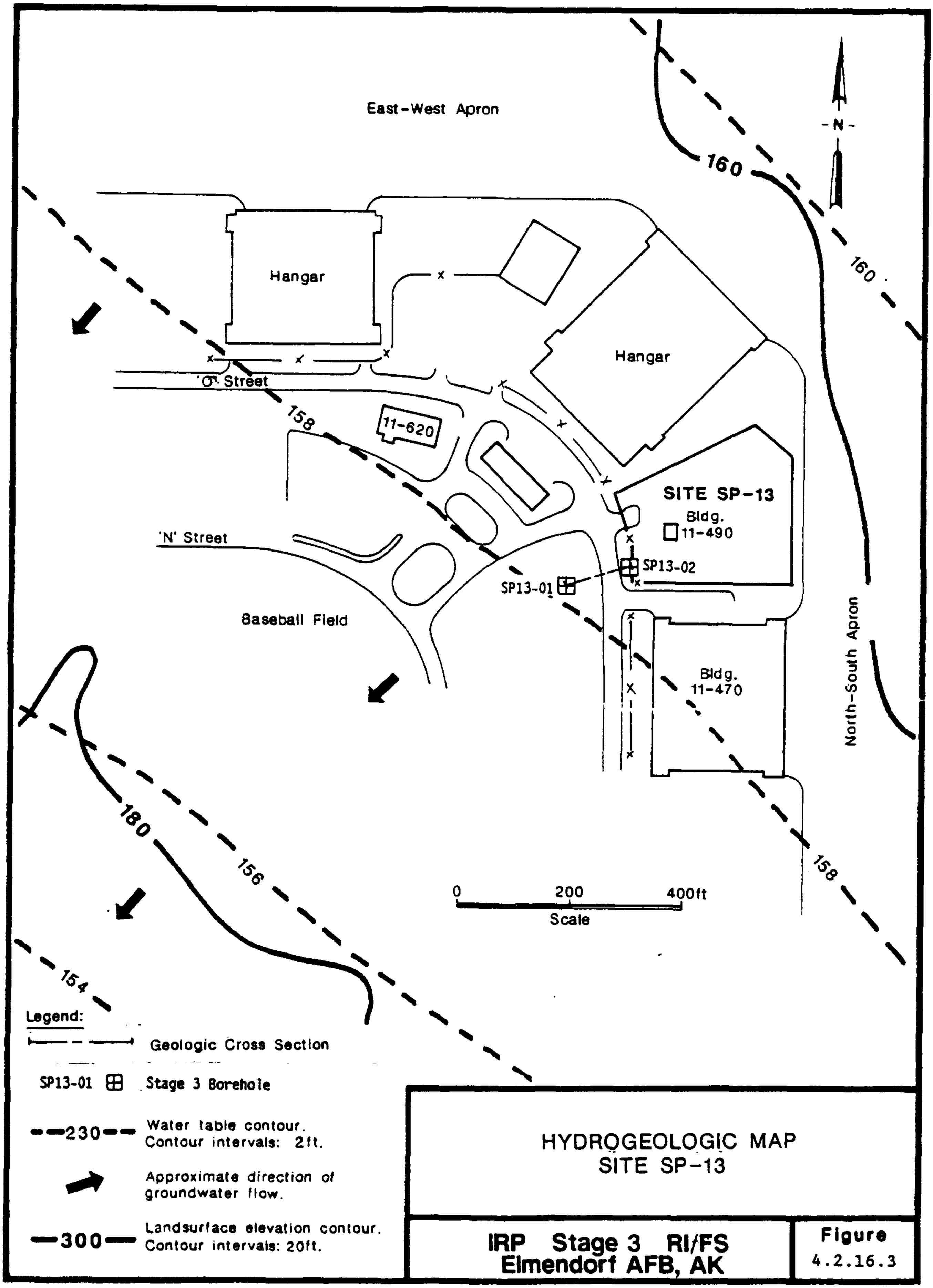


Notes:

1. Geologic cross section line is shown on Figure 4.2.16.3
2. Water table is below a depth of 5 feet.

GEOLOGIC CROSS SECTION
ADJACENT TO SITE SP-13

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.16.2


East-West Apron
160
160
Hangar
Hangar
'O' Street
158
11-620
SITE SP-13
Bldg.
11-490
SP13-02
SP13-01
'N' Street
Baseball Field
Bldg.
11-470
North-South Apron
180
156
158
154
0
200
400ft
Scale
Legend:
Geologic Cross Section
SP13-01 Stage 3 Borehole
230 Water table contour. Contour intervals: 2ft.
Approximate direction of groundwater flow.
300 Landsurface elevation contour. Contour intervals: 20ft.
HYDROGEOLOGIC MAP
SITE SP-13
IRP Stage 3 RI/FS
Elmendorf AFB, AK
Figure
4.2.16.3

4.2.16.1.3.1 Field Analytical Results and Observations

HNu readings during drilling were at background levels. Neither petroleum odors nor ground staining were observed during the field investigation of the site.

4.2.16.1.3.2 Laboratory Analytical Results

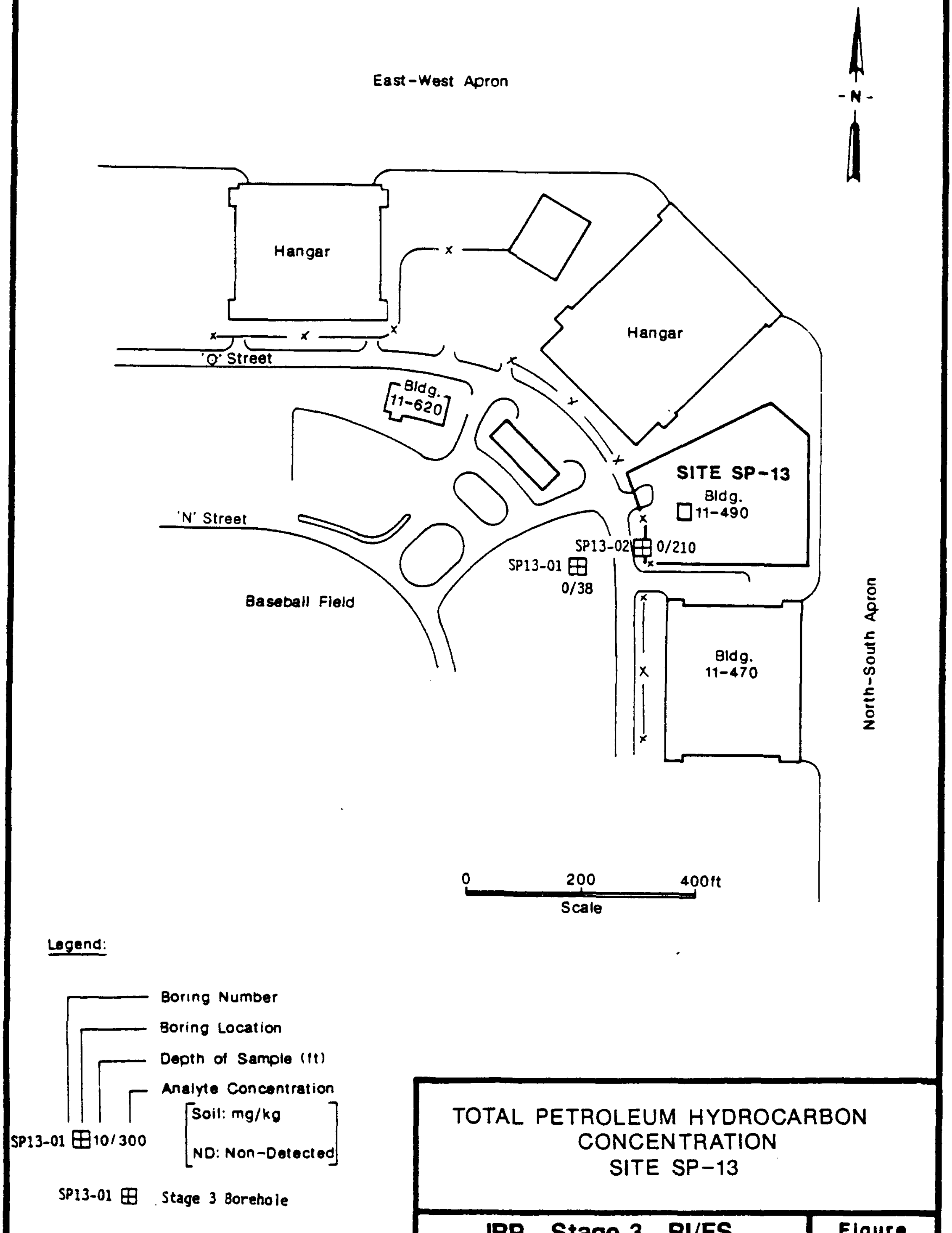
The laboratory analytical program for Site SP-13 is presented in Table 4.2.16.1, and the sample plan for the base-wide field investigation is included in Appendix B. Major organic contaminants identified from the laboratory analysis of samples collected at Site SP-13 are plotted in Figures 4.2.16.4 through 4.2.16.9. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding boring. Sampling depth is included for the soil samples. Isoconcentration lines were not drawn due to the few pcints having detectable contamination for each analyte.

4.2.16.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site SP-13 are presented on Table 4.2.16.2.

4.2.16.1.5 Discussion of Analytical Data

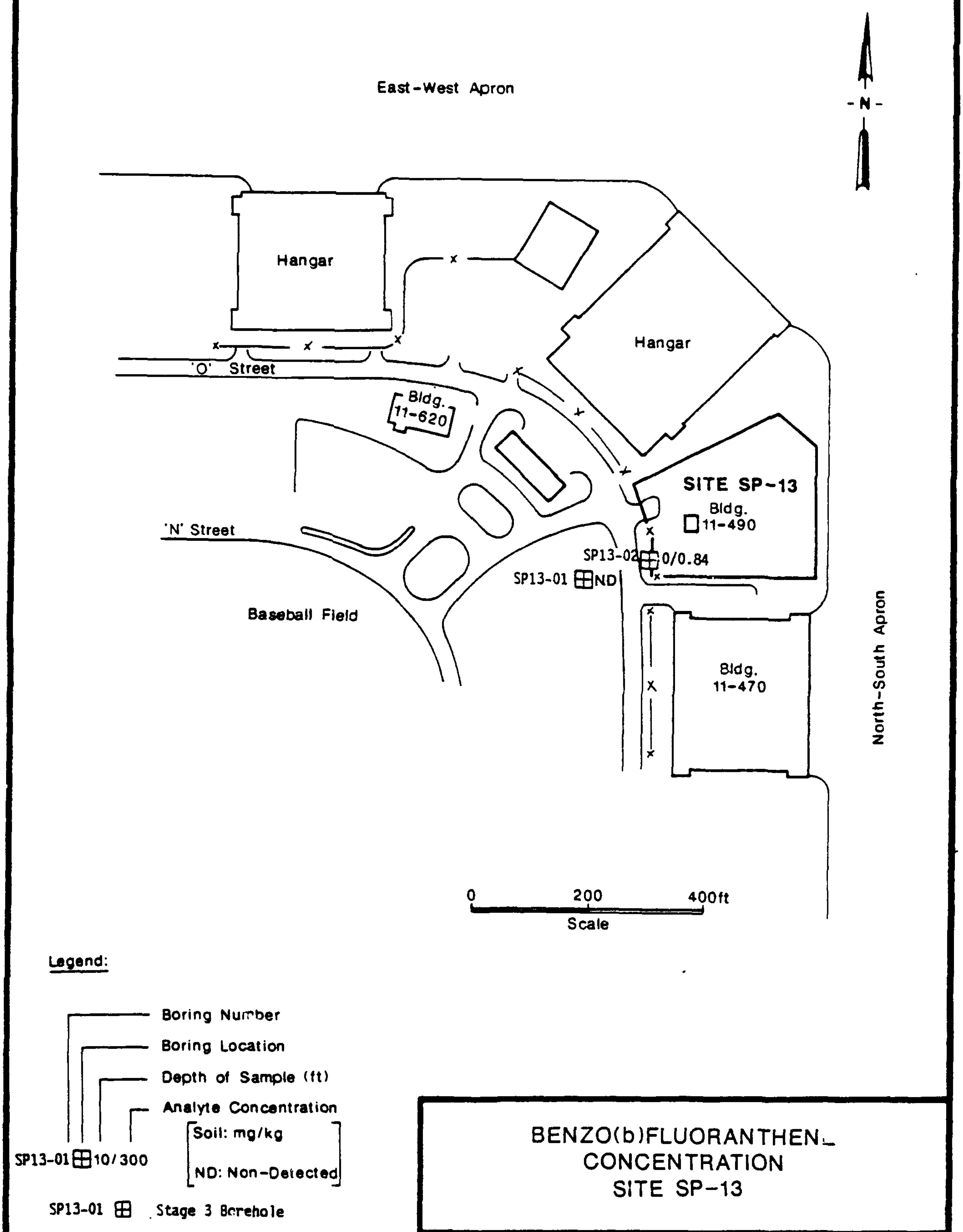
Petroleum hydrocarbons were detected in soil samples from Site SP-13. Total petroleum hydrocarbon concentrations in surface soil samples were 38 and 210 mg/kg for borings SP13-01 and SP13-02, respectively.



TOTAL PETROLEUM HYDROCARBON CONCENTRATION
SITE SP-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

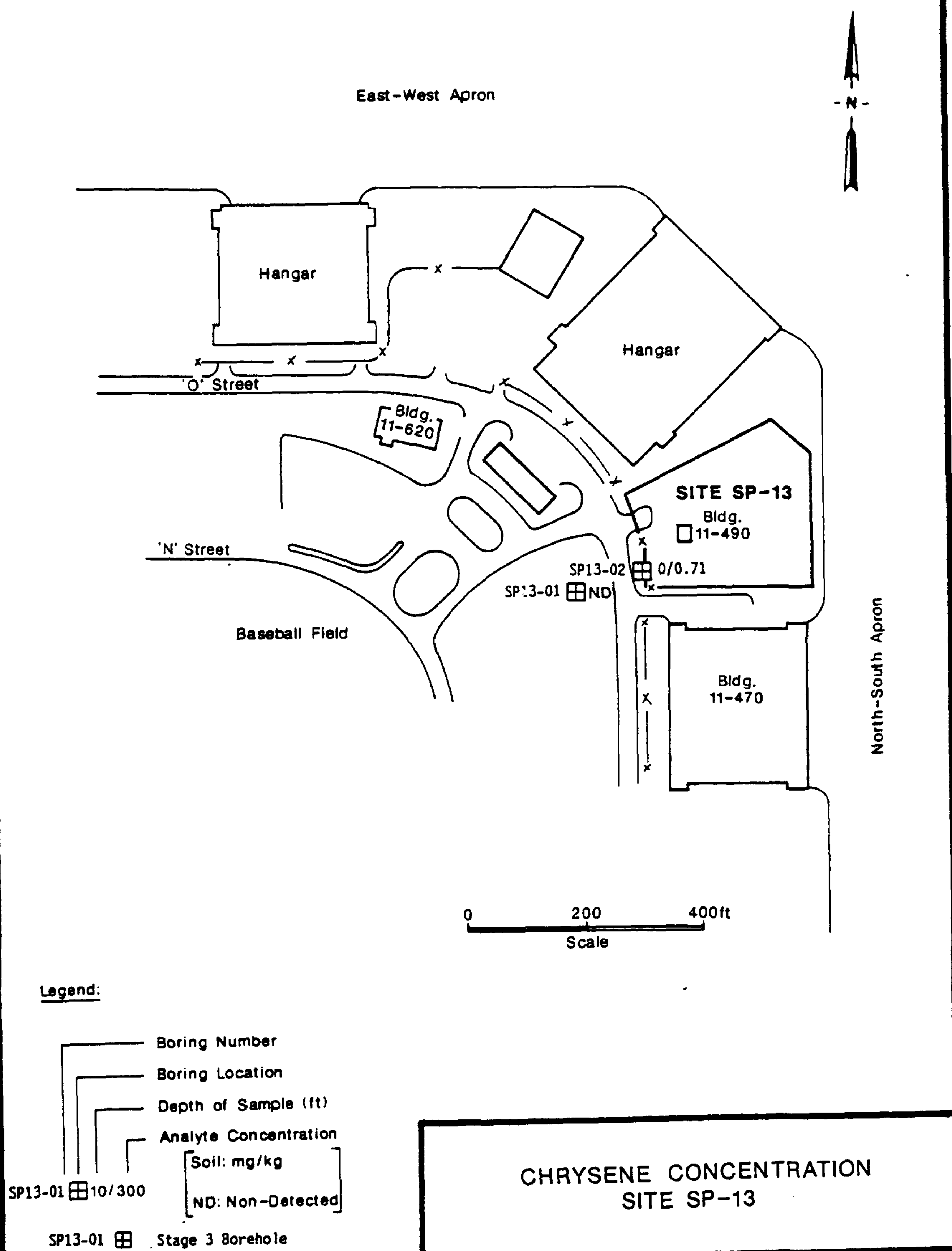
Figure
4.2.16.4



BENZO(b)FLUORANTHENE
CONCENTRATION
SITE SP-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

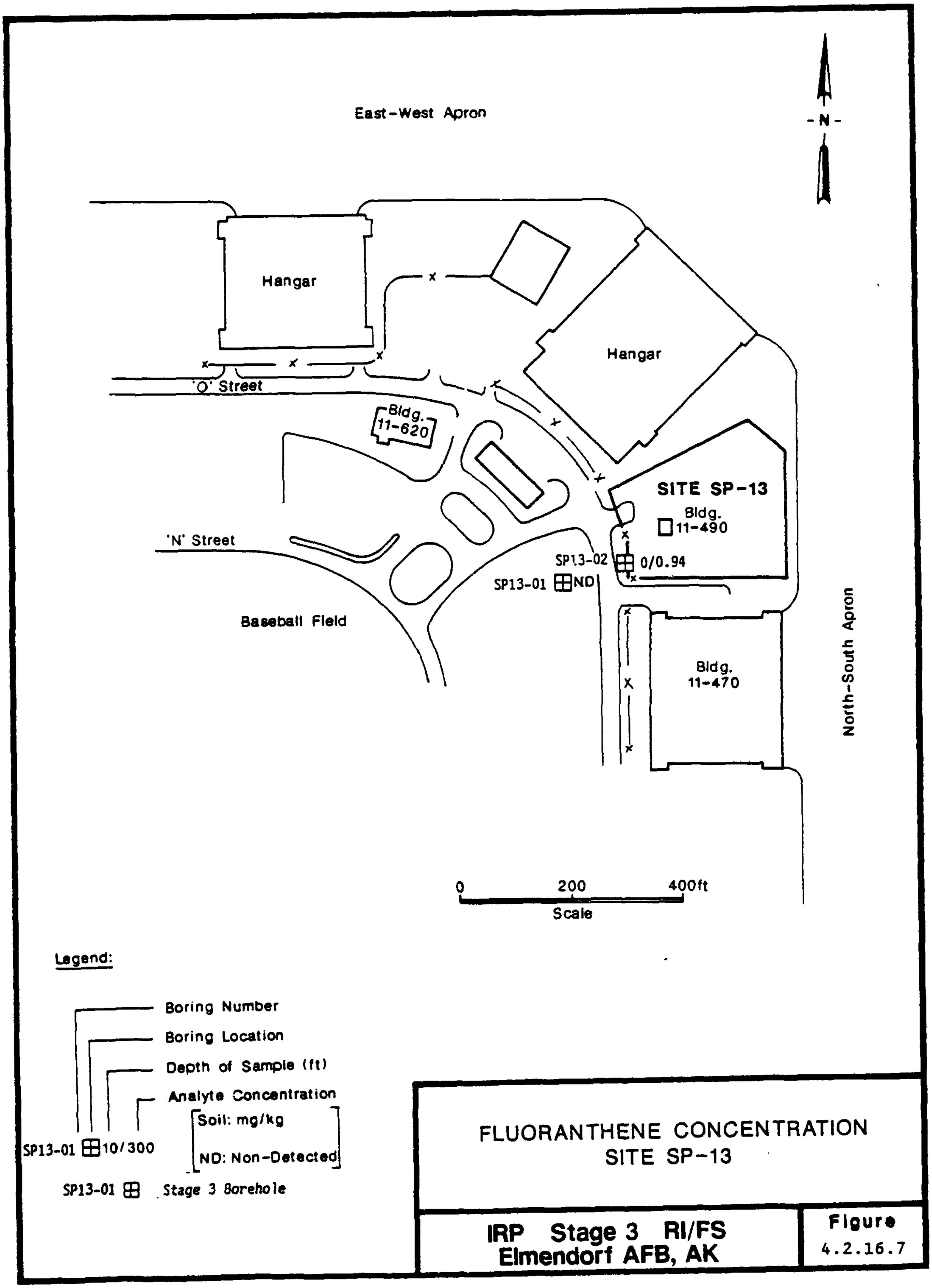
Figure
4.2.16.5



CHRYSENE CONCENTRATION
SITE SP-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

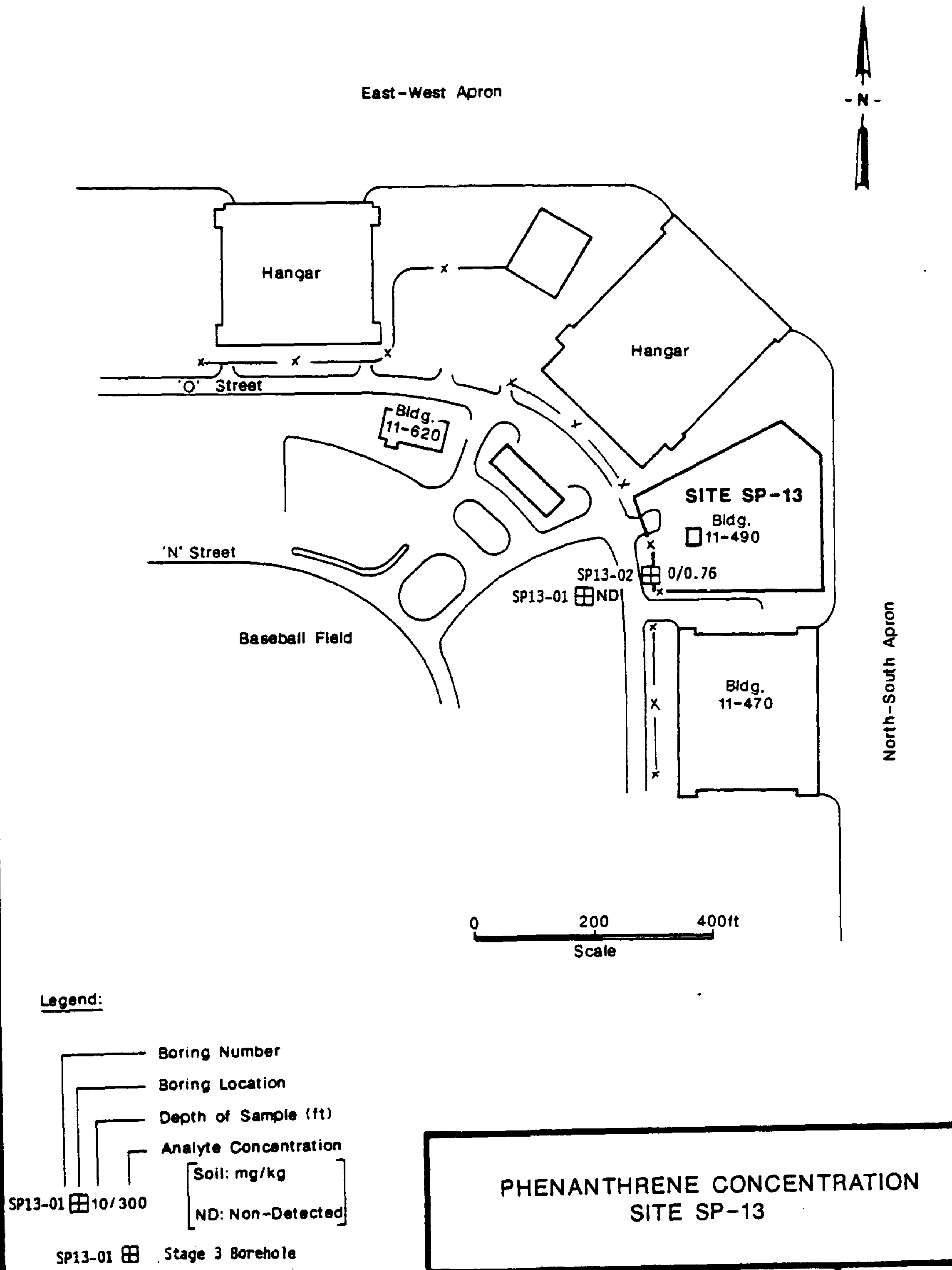
Figure 4.2.16.6



FLUORANTHENE CONCENTRATION
SITE SP-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

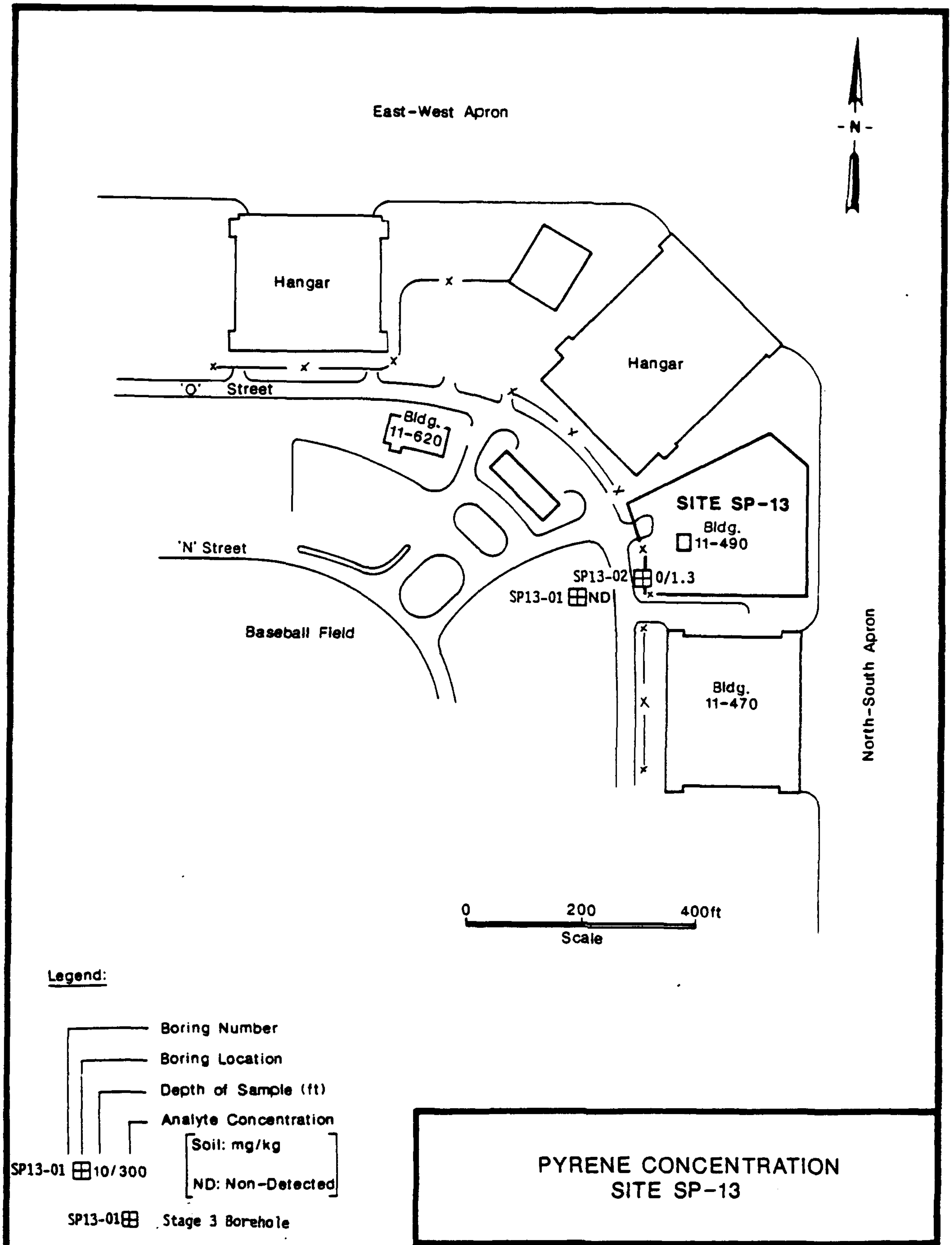
Figure 4.2.16.7



PHENANTHRENE CONCENTRATION
SITE SP-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.16.8



PYRENE CONCENTRATION
SITE SP-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.16.9

In addition, surface soil from boring SP13-02 contained the following polycyclic aromatic hydrocarbons (PAH): benzo(b)fluoranthene (0.40 mg/kg), chrysene (0.71 mg/kg), fluoranthene (0.94 mg/kg), phenanthrene (0.76 mg/kg), and pyrene (1.3 mg/kg).

Table 4.2.16.1 Requested Laboratory Analyses for Samples Taken at Site SP-13

SOIL

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
8240	Volatile Organic Compounds
8270	Semi-volatile Organic Compounds
160.3	Soil Moisture Content

4.2.16.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site SP-13 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the workplan.

4.2.16.2.1 Loss of Samples

No soil samples collected for laboratory analysis were lost from Site SP-13.

4.2.16.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water

Table 4.2.16.2

Analytical Results - Site SP-13

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP13-02 0'-5' 0687-SO-095 GS-88-0001 001170-0002	SP13-01 0'-5' 0687-SO-094 GS-88-0001 001170-0001
Benzo(b)fluoranthene	Method 8270	mg/kg		0.84	
Chrysene	Method 8270	mg/kg		0.71	
Fluoranthene	Method 8270	mg/kg		0.94	
Phenanthrene	Method 8270	mg/kg		0.76	
Pyrene	Method 8270	mg/kg		1.3	
Total Petroleum Hydrocarbons	3550/418.1 Mod.	mg/kg		209	
Total Solids	160.3	%		44	
				95.8	

sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in samples from the site.

4.2.16.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Two soil samples were collected from 2 shallow borings at Site SP-13. No out-of-control conditions occurred during drilling, sampling and laboratory operations.

4.2.16.3 Significance of Findings

Analytical methods detected petroleum hydrocarbons and polycyclic aromatic hydrocarbon (PAH) in soil samples from Site SP-13. The petroleum hydrocarbon concentrations of 210 mg/kg from boring SP13-02 exceeds the levels suggested by interim ADEC soil cleanup guidelines as discussed in Section 4.1.

The source of petroleum hydrocarbons in the soil is a diesel fuel spill.

Pathways of exposure are ingestion or handling of the contaminated soil by humans, wildlife, or plants. If surface and/or groundwater is determined to be contaminated at this site, then ingestion by humans and wildlife, or uptake by plants constitutes an additional pathway. However, since completion of the field investigation, an asphalt parking lot has been installed over the contaminated area. Therefore, contact with or inhalation of the contaminated soil is not possible. Also, the parking lot will prevent precipitation from entering the soil. Therefore, contaminants will not leach to the groundwater.

4.2.16.3.1 Zones of Contamination

Organic contaminants were detected as total petroleum hydrocarbons in surface soil samples from borings SP13-01 and SP13-02. PAH compounds were also detected in the surface soil sample from boring SP13-02. HNU readings were at background levels and petroleum odors were not detected during soil sampling. Contamination was not detected in subsurface soil samples.

4.2.16.3.2 Contaminant Migration

Drilling and sampling operations at Site SP-13 reached only to a depth of five feet, which is above the depth of groundwater. Therefore, it was not possible to determine if the groundwater is contaminated in the vicinity of Site SP-13. Contamination of the groundwater from sources at Site SP-13 is possible since laboratory analyses of soils detected contamination. However, contamination was detected at surface levels, and, since the installation of the asphalt parking lot, the potential for contamination leaching to the groundwater has been removed. PAHs typically have low vapor pressures, so vapor-phase migration is not likely either.

4.2.16.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off-Base subsurface migration of contamination is unknown. The direction of subsurface flow in the vicinity of Site SP-13, assumed to be to the southwest (Figure 4.2.16.3), has not been confirmed.

Offsite migration of contamination would not occur through surface runoff water contaminated by organics in surface soils. This is due to the installation of the asphalt parking lot, which as as a cap.

4.2.16.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site inferred that the direction of groundwater flow is to the southwest. The hydraulic gradient is 15 feet per mile, but the horizontal hydraulic conductivity has not been estimated.

4.2.16.3.2.3 Time of Travel to Receptors

The primary receptors are humans, wildlife and plants. Primary pathways are ingestion and handling of contaminated soil, plants, or groundwater. However, exposure to the contaminated soil or plants is improbable due to the presence of the asphalt parking lot, which prevents migration of contamination. Time or travel of groundwater contamination to Ship Creek cannot be determined as hydraulic conductivity values have not yet been established for this site.

4.2.16.3.2.4 Expected Spatial and Temporal Variations in Concentration

Since groundwater in the area of this site was not sampled as part of this study, variations in contamination of the groundwater is unknown. Spatial variations in soil contamination are identified; boring SP13-02 contained higher concentrations of petroleum hydrocarbons than boring SP13-01 and boring SP13-02 contained polycyclic aromatic hydrocarbons while boring SP13-02 did not. There is no available temporal data for the site.

4.2.16.3.3 Baseline Risk Assessment

The contamination in relation to exposure routes, receptors, and health effects are evaluated in the following sections.

4.2.16.3.3.1 Waste Characterization

Petroleum hydrocarbons and PAH have been detected in soils at this site. In general, petroleum hydrocarbons are not considered to be highly toxic, but can have slight anesthetic effects.

PAH compounds detected at Site SP-13 include: phenanthrene, chrysene, fluoranthene, benzo(b)fluoranthene and pyrene. All are substances commonly found in coal tars, and all have suspected tumorigenic neoplastic effects.

4.2.16.3.3.2 Source and Release Characterization

Hydrocarbon compounds may have leached into surface and subsurface soils from diesel fuel spilled at this site. The volume of fuel spilled was 800 gallons, none of which was cleaned up or recovered (Engineering-Science, 1983).

4.2.16.3.3.3 Fate and Transport of Contaminants

The fate of chemicals released to the environment at Site SP-13 includes long-term natural degradation, dispersion of the contaminants through surface runoff, or uptake by living organisms.

Contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration along hydrologic gradients. Additional transport can occur in the form of surface runoff or release of vapor to the atmosphere. Contaminated soil or water from the site can be transported through human intervention. However, as previously discussed, contamination at this site is fixed in place by the presence of an asphalt parking lot.

4.2.16.3.3.4 Exposure Pathways

The exposure pathway for humans and wildlife is contact with or ingestion of contaminated soils, runoff, plants, or groundwater..

4.2.16.3.3.5 Identification of Receptors

Receptors are humans, wildlife, and plants. The site is adjacent to a road and a heavily-used parking lot. A baseball field is situated approximately 400 feet to the west. The site is easily accessed. Wildlife is not abundant in the vicinity of the site due to development of the area.

4.2.16.3.3.6 Threat to Human Health

There is a slight threat to human health from contaminated surface soils at Site SP-13. The site is easily accessible, and surface soils are contaminated. Groundwater contamination is not known.

4.2.16.3.3.7 Carcinogenic Risks

No carcinogenic compounds were detected by the analyses performed on soil samples from Site SP-13. However, the PAH compounds detected in a surface soil sample may have tumorigenic effects if ingested.

4.2.16.3.3.8 Threat to Wildlife

Threat to wildlife is not possible through contaminated surface soils, plants, or surface water runoff from the site, since the contamination has been contained by the parking lot.

4.2.16.4 Prioritization of Sites for Remedial Alternatives (SP-13)

Site SP-13 is assigned low priority for remedial alternatives due to the low toxicity of petroleum hydrocarbons and PAHs detected in soils at surface levels.

Further work at this site should include a soil gas survey to better characterize the area of contamination. Results of the soil gas survey should be used to place a boring/monitoring well at Site SP-13. The well should be located southwest and downgradient of the site. Groundwater from the well should be sampled and tested for TPH purgeable aromatics and polynuclear aromatic hydrocarbons. A minimum of 2 soil samples should be collected form the boring and analyzed for TPH, VOCs, and polynuclear aromatic hydrocarbons. In addition, a measurement of floating fuel product thickness will be taken if fuel product is observed floating at the surface of the groundwater in the well.

4.2.17 Discussion of Results for Site SP-14, MOGAS Spill

Site SP-14 is the location of a 1500 gallon motor gasoline (MOGAS) spill that occurred in 1965 (Figure 4.2.17.1). The fuel, which was not recovered, seeped into the porous gravel of the area.

4.2.17.1 Presentation of Results at Site SP-14

Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site location maps.

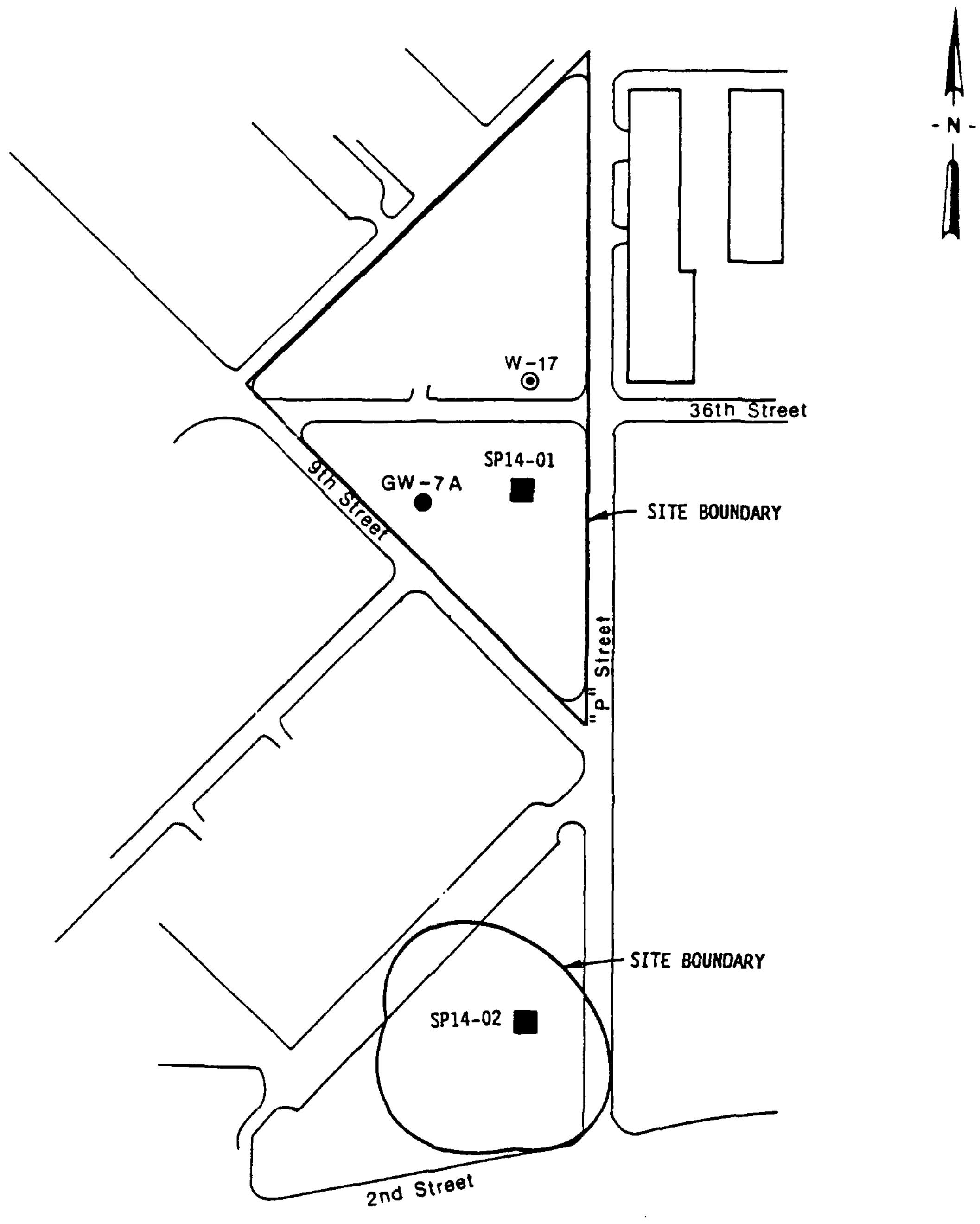
4.2.17.1.1 Site Geology

Site SP-14 is located at an elevation of 180 feet on flat terrain underlain by late-Quaternary glacial outwash deposits consisting chiefly of sands, gravels and some silt. A schematic geologic cross-section of the site is presented on Figure 4.2.17.2. The site has been developed with numerous roads and buildings.

Two borings, each completed as monitoring wells, were drilled at the site. The northern boring, well SP14-01, encountered a well-graded sandy gravel to a depth of 40 feet. The southern boring, well SP14-02, encountered sandy silts to 15 foot depth underlain by well-graded sandy gravel to a depth of 45 feet. A gamma log performed on well SP14-02 also indicated a surficial silt-rich layer. Boring logs are presented in Appendix C, and the interpreted gamma logs are included in Appendix D.

4.2.17.1.1.2 Site Hydrogeology

Site SP-14 is underlain by sands and gravels with some silts. The water table is at depths ranging from approximately 1 foot to 35 feet.



Legend:

W-17 Monitoring Well Location, Phase II, Stage 1

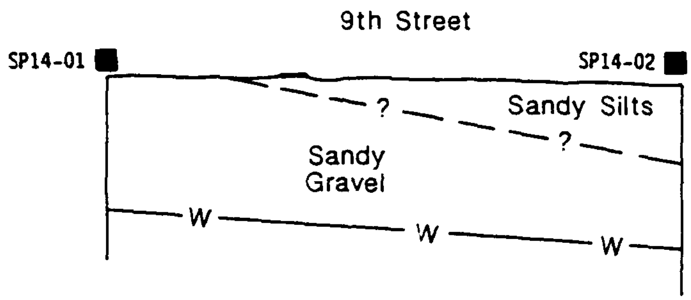
GW-7A Monitoring Well Location, Phase II, Stage 2

SP14-01 Monitoring Well Location Stage 3

LOCATION MAP
SITE SP-14

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.17.1



Legend:

SP14-01 ■ Monitoring Well Location Stage 3

— W — Projected Water Table

— — — Inferred Contact

0 200 400ft

HORIZONTAL SCALE

0 20 40ft

VERTICAL SCALE

Notes:

1. Horizontal scale: 1 inch = 200 feet.
2. Vertical scale: 1 inch = 40 feet.
3. Cross section location shown on Figure 4.2.17.3

GEOLOGIC CROSS SECTION
SITE SP-14

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.17.2

The direction of groundwater flow is based on comparison of regional trends and water level measurements at 9 wells in the area. The groundwater flow direction is south-southwest with a gradient of approximately 60 feet per mile (Figure 4.2.17.3). Hydraulic conductivity values have not yet been established for this site.

4.2.17.1.3 Analytical Results

Field analytical results and observations and laboratory analytical results are discussed in the following sections.

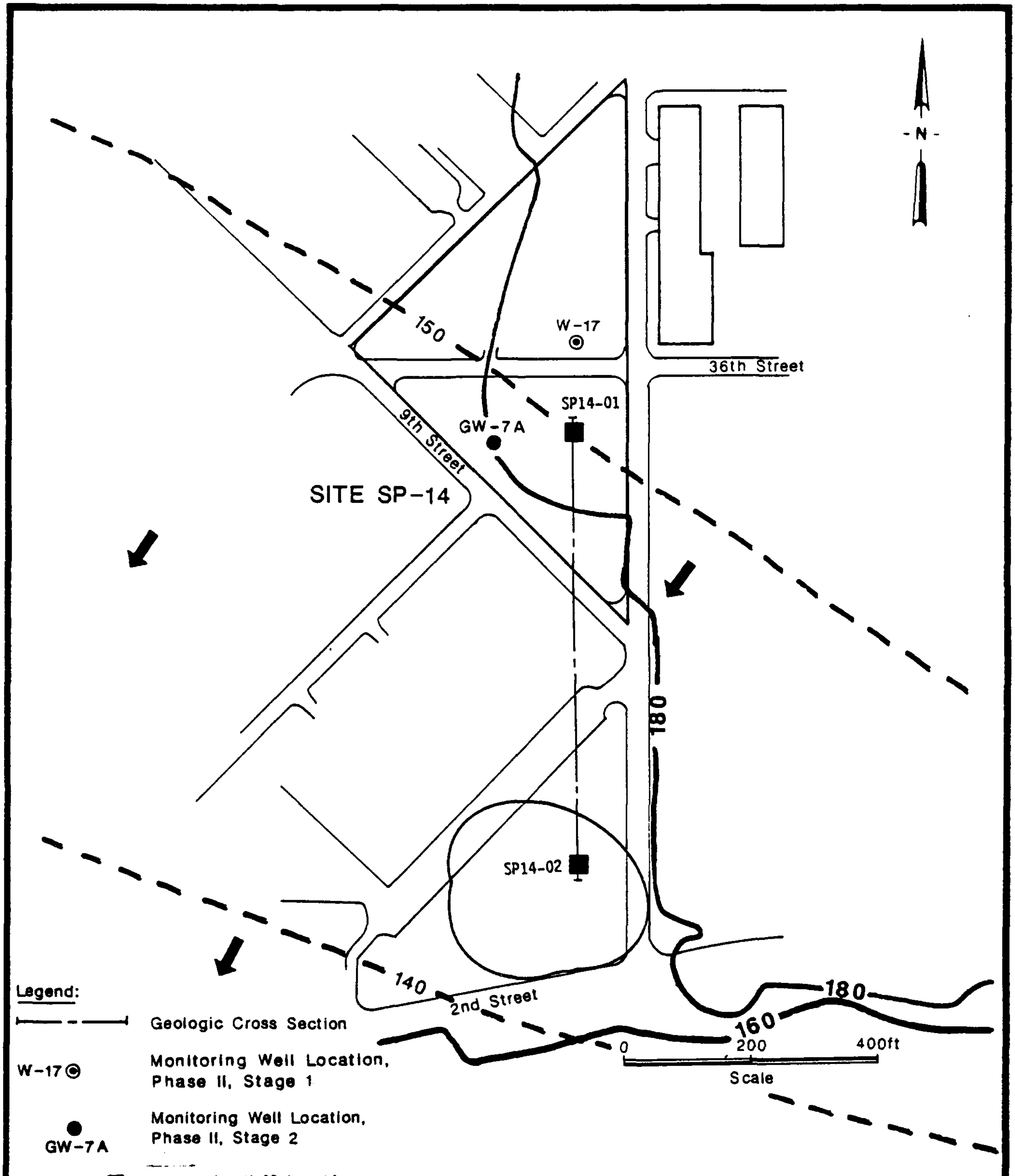
4.2.17.1.3.1 Field Analytical Results and Observations

Results of the soil gas survey conducted at Site SP-14 are presented on Figure 4.2.17.4 and in Table 4.2.17.1. Isoconcentration contours have been drawn based on the findings of the field analysis. In addition to the soil gas survey, visual observations were made in the field at subsurface investigative sites. No evidence of contamination was observed at well SP14-02. At well SP14-01, the HNu reading at 5 feet was 2.5 ppm with no petroleum odor. The HNu reading at 10 feet was 15 ppm with no petroleum odor. The HNu reading at 30 feet was 25 ppm with a petroleum odor.

Field parameters measured at Site SP-14 during groundwater sampling are provided in Table 4.2.17.2.

4.2.17.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site SP-14 is presented in Table 4.2.17.3, and the sample plan for the base-wide field investigation program is included in Appendix B. Major organic contaminants identified from the laboratory analysis of samples collected at Site SP-14 are plotted on Figures 4.2.17.5, 4.2.17.6, and 4.2.17.7. A



Legend:

Geologic Cross Section

W-17 Monitoring Well Location, Phase II, Stage 1

GW-7A Monitoring Well Location, Phase II, Stage 2

SP14-01 Monitoring Well Location Stage 3

Approximate direction of groundwater flow.

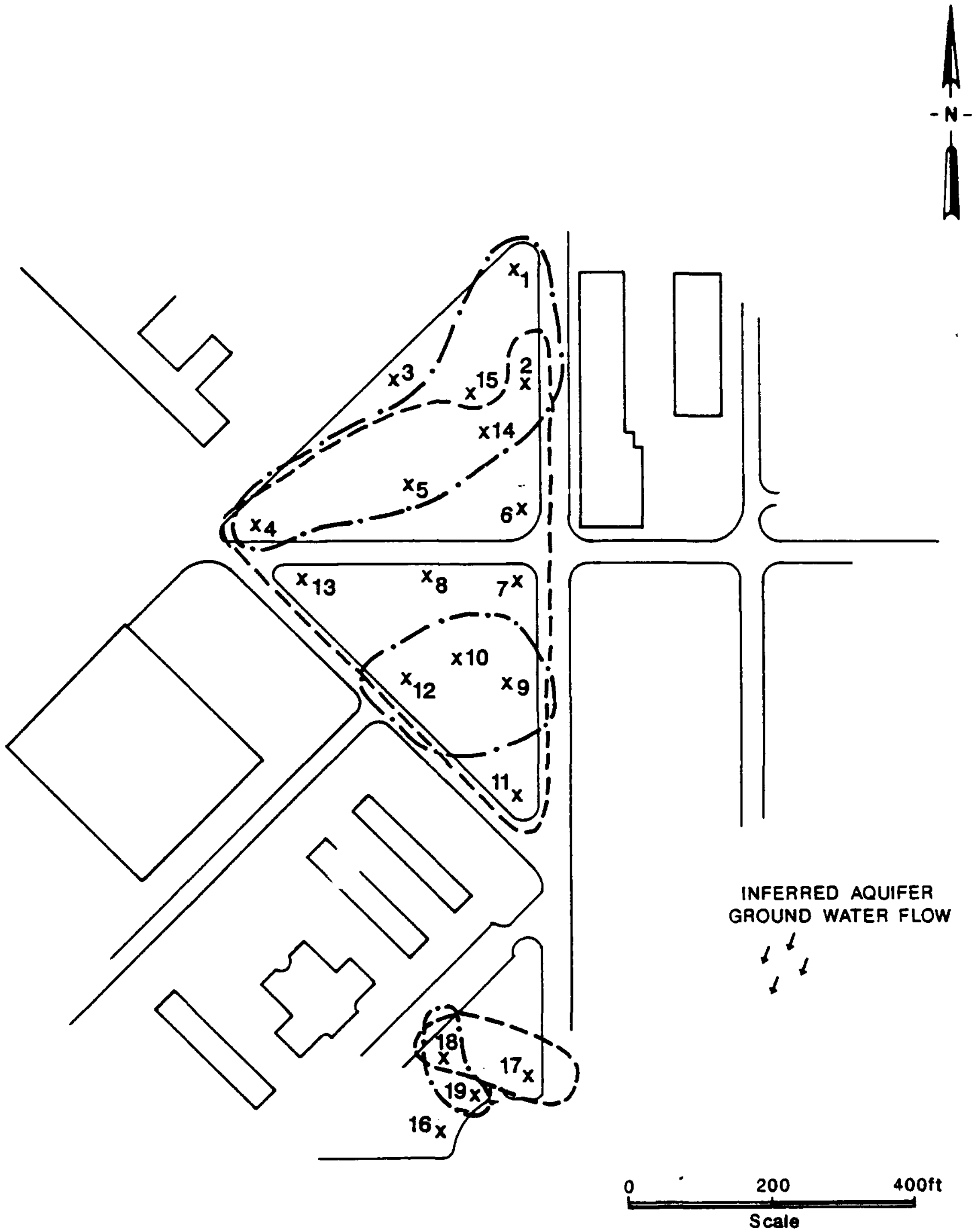
--230-- Water table contour. Contour intervals: 10ft.

—300— Landsurface elevation contour. Contour intervals: 20ft.

HYDROGEOLOGIC MAP
SITE SP-14

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.17.3



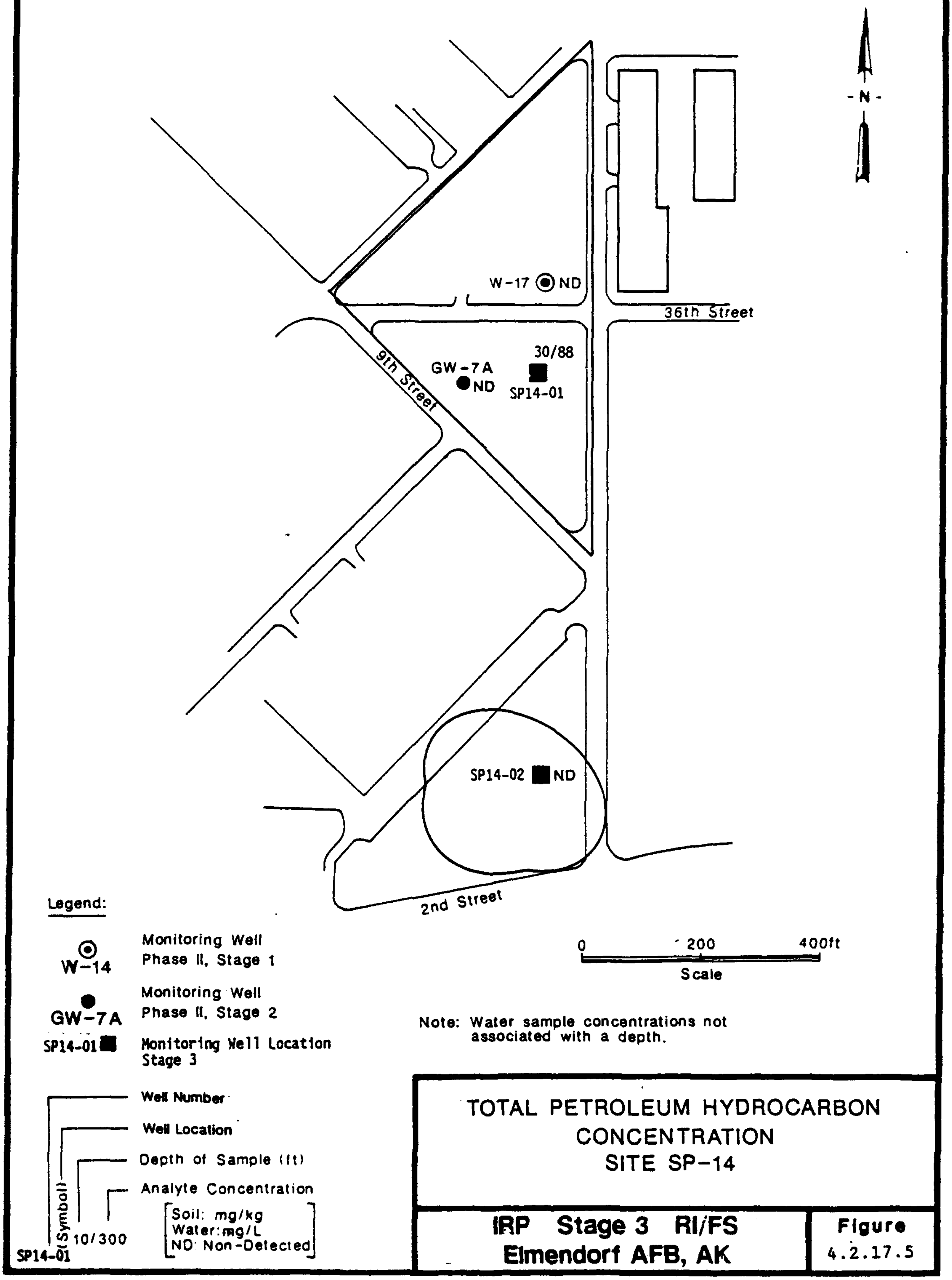
Legend:

—·——·—	Detectable Unidentified Organic Contamination
— — — — —	Detectable BTX Contamination
x1	Probe Location

SOIL GAS SURVEY
LOCATIONS AND RESULTS
SITE SP–14

IRP Stage 3 RI/FS
Elmendorf AFB, AK

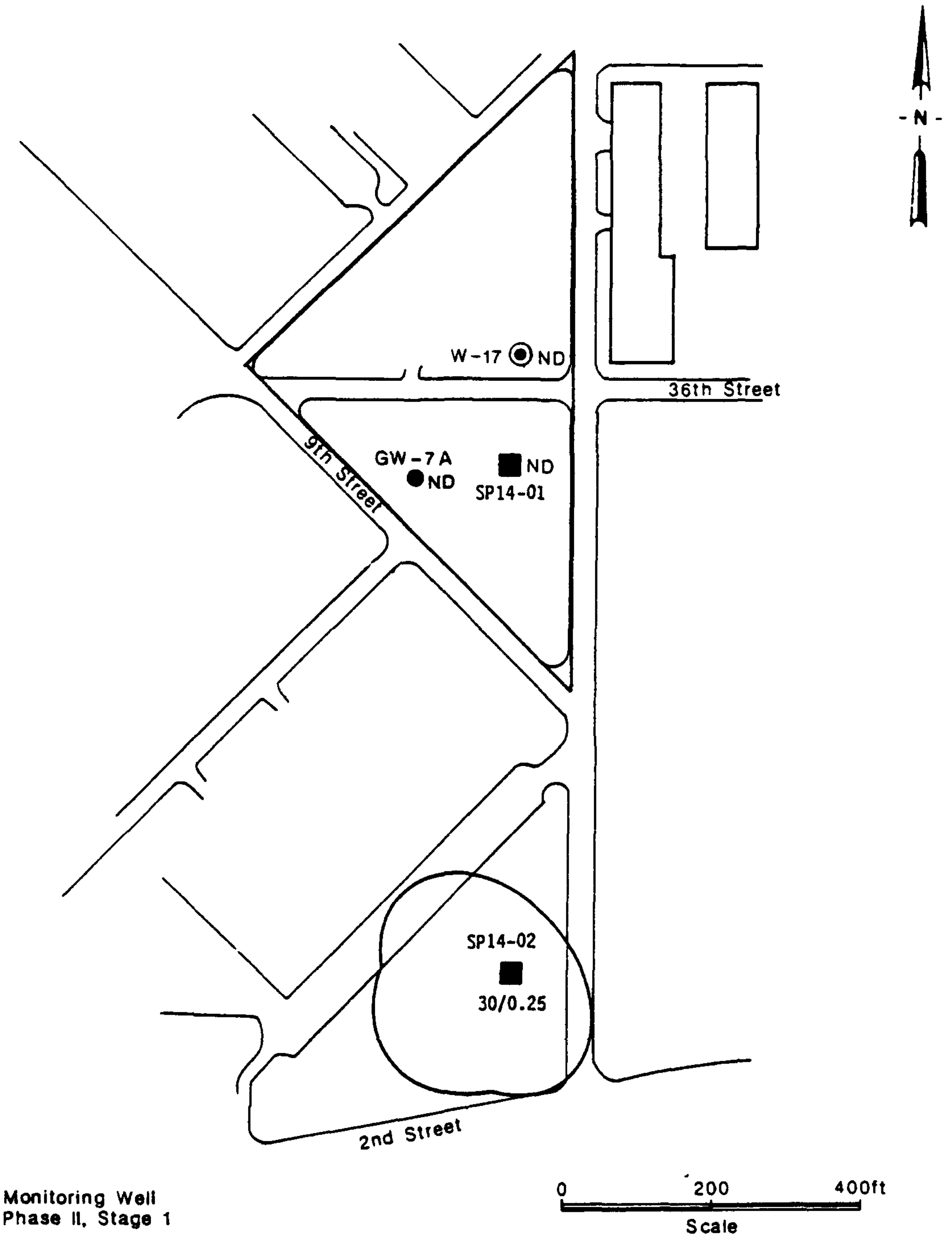
Figure 4.2.17.4



TOTAL PETROLEUM HYDROCARBON CONCENTRATION SITE SP-14

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.17.5



Legend:

W-17	Monitoring Well Phase II, Stage 1
GW-7A	Monitoring Well Phase II Stage 2
SP14-01	Monitoring Well Location Stage 3

SP14-01 Symbol 10/300

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration

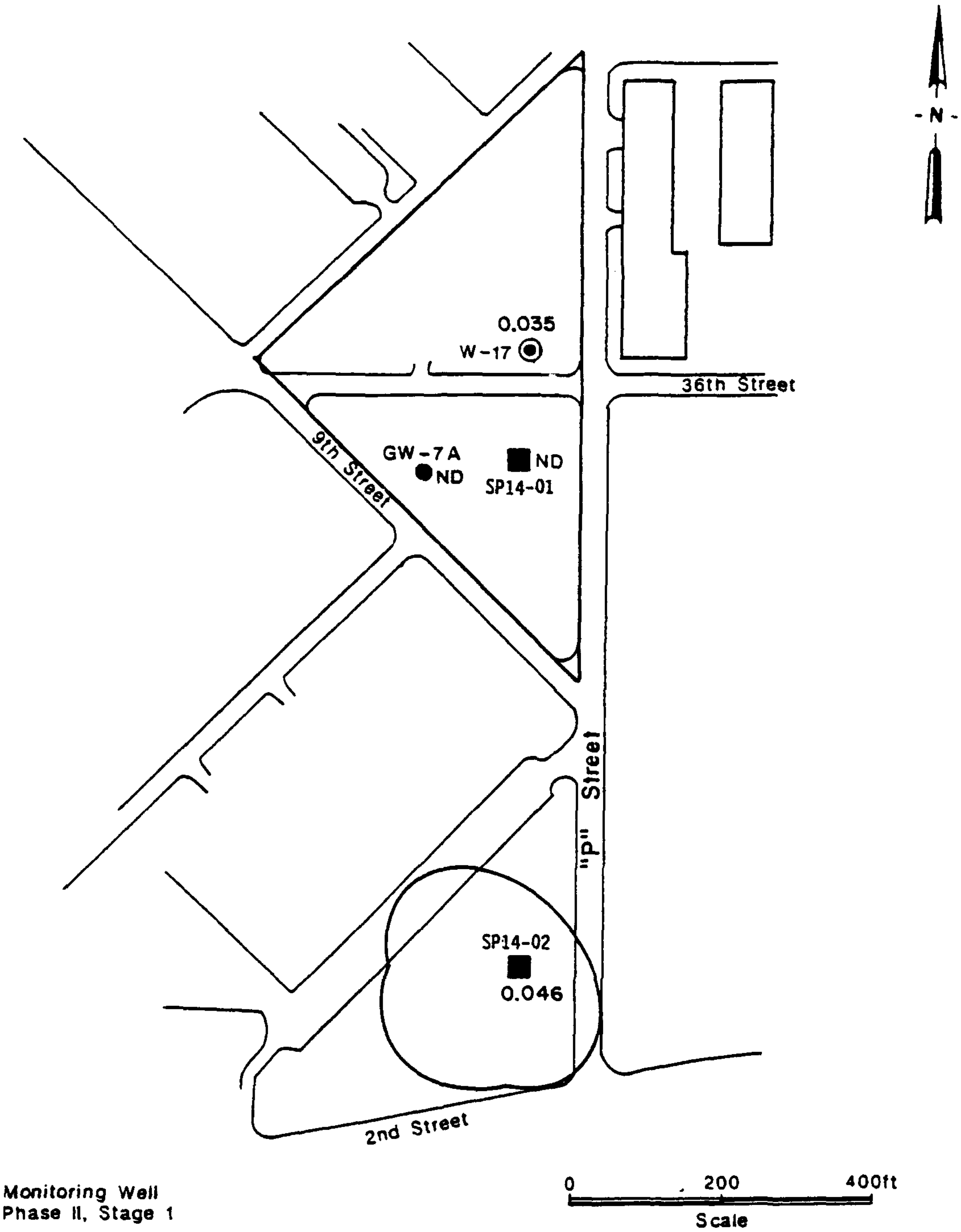
[Soil: mg/kg
Water: µg/L
ND Non-Detected]

Note: Water sample concentrations not associated with a depth.

2-BUTANONE CONCENTRATION SITE SP-14

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.17.6



Note: Water sample concentrations not associated with a depth.

Legend:

W-17 — Monitoring Well Phase II, Stage 1

GW-7A — Monitoring Well Phase II Stage 2

SP14-01 — Monitoring Well Location Stage 3

SP14-01 — Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

(Symbol)

10/300

[Soil: mg/kg
Water: µg/L
ND: Non-Detected]

1,2-DIBROMOETHANE (EDB)
CONCENTRATION
SITE SP-14

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.17.7

Table 4.2.17.1 Summary of Soil Gas Chromatograph Analyses at Site SP-14

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)	Comments
1	8.5	-	TR	TR	.72	Unidentified organics is at 1.1 RT
2	8	.09	4.19	TR	.24	
3	10	.34	.17	-	TR	
4	10	-	.88	-	.20	
5	10	-	.44	-	.22	
6	8	-	.24	-	-	
7	5	3.42	1.09	TR	-	
	10	.32	-	-	.08	
8	5	-	1.55	TR	-	
	10	-	1.86	-	-	
9	5	-	1.14	TR	.67	
	10	-	.74	TR	.41	
10	5	-	.79	TR	-	
11	10	-	.57	-	TR	
12	10	.46	.80	TR	.54	
13	10	-	TR	.71	-	
14	5	-	.28	-	.70	
	10	-	.87	TR	.79	
15	10	-	-	-	.71	
16	6	-	TR	TR	-	
17	8	3.71	TR	-	-	
18	10	.58	TR	TR	.26	
19	6.5	-	TR	-	.61	

Note: Unidentified organics are reported in benzene equivalent ppm.
TR - Trace.
RT - Retention Time

Table 4.1.17.2 Field Parameters, Site SP-14

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
SP14-01	8/11/88	8.5	322	6.86	180	No odor or sheen
SP14-02	8/11/88	7.0	275	6.79	142	No odor or sheen
W-17	8/11/88	8.5	310	7.60	158	No odor or sheen
GW-7A	8/11/88	9.0	345	7.03	156	No odor or sheen

Table 4.1.17.3 Requested Analyses for Laboratory Samples at Site SP-14

<u>SOIL/SEDIMENT</u>

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
7421	Lead
8240	Volatile Organic Compounds
160.3	Soil Moisture Content

<u>WATER</u>

Test Number	Analysis
418.1	Petroleum Hydrocarbons
504	1,2-Dibromoethane (EDB)
239.2	Lead (total and dissolved)
602	Purgeable Aromatics

separate map for each identified organic contaminant is provided. The analyte concentrations are plotted next to the corresponding well or test boring. Sampling depths are included for the soil samples.

4.2.17.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site SP-14 are presented in Table 4.2.17.4.

4.2.17.1.5 Discussion of Analytical Data

Petroleum hydrocarbon compounds were detected in soil and water samples from Site SP-14; however, concentrations were low and limited to 1 or 2 samples. For example, the total petroleum hydrocarbon concentration was 88 mg/kg in a soil sample from well SP14-01. In addition, the compound 2-butanone was detected in a soil sample from well SP14-02 at a concentration of 0.25 mg/kg..

EBD (1,2-Dibromoethane) was detected at low levels in 2 of the 4 wells, W-17 at 0.035 ug/L and well SP14-02 at 0.046 ug/L.

Dissolved lead was detected in water samples from all 4 wells at the site. Concentrations ranged from 0.003 mg/L in a sample from well W-17 to 0.066 mg/L from well GW-7A. Lead was not detected in any of the soil samples submitted for analysis during the Stage 3 investigation..

4.2.17.2 Sampling or Analytical Problems

Sampling or analytical problems including loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan at Site SP-14 are addressed below.

Table 4.2.17.4

Analytical Results - Site SP-14

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	W-17 0687-NG-098 GN-88-C001 001221-0003	W-17 DUPLICATE 0687-NG-098 GN-88-0001 001221-0003	W-17 RESAMPLE 0687-NG-098 GN-89-0002R 003791-0003	W-17 GN840267	W-17 30' W-17-7	W-17 35' W-17-8	W-17 W-17/21
2-Butanone	Method 8240	mg/kg	2,500							
Dissolved Lead	239.2	mg/L	0.05	0.003	0.007					
EDB (1,2-Dibromoethane)	METHOD 504	ug/L			0.005	0.035				
LEAD	239.1	mg/kg	70					20	25	
MOISTURE	GRAV.	%						31	29	
OIL & GREASE	413.2	mg/L					4.7	1330		
Recoverable Lead	239.2	mg/L	0.05	0.004						
Total Dissolved Solids	160.1	mg/L	500							270
Total Petroleum Hydrocarbons	3550/418.1 Mod.				280.					
Total Solids	160.3	%			0.8					

Table 4.2.17.4

Analytical Results - Site SP-14

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP14-01 0687-NG-096 GW-88-U003 001221-0002	SP14-01 5'-6.5' 0687-SO-096,GS-88-0001 001017-0010	SP14-01 30'-31.5' 0687-SO-096,GS-88-0002 001017-0011	GW-7A 0687-NG-099 GW-88-0001 001221-0006	GW-7A GW-7A/15	SP14-02 0687-NG-097 GW-88-0003 001221-0004
2-Butanone	Method 8240	mg/kg	2,500						
Dissolved Lead	239.2	mg/L	0.05	0.052			0.066		0.065
EDB (1,2-Dibromoethane)	METHOD 504	ug/L							
LEAD	239.1	mg/kg	70						
MOISTURE	GRAV.	%							
OIL & GREASE	413.2	mg/L							
Recoverable Lead	239.2	mg/L	0.05				0.066		0.030
Total Dissolved Solids	160.1	mg/L	500					330	
Total Petroleum Hydrocarbons	3550/418.1 Mod.					88			
Total Solids	160.3	%			96.8	90.9			

Table 4.2.17.4

Analytical Results - Site SP-14

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP14-02 RESAMPLE 0687-NG-097 GN-89-0004R 003791-0002	SP14-02 10'-11.5' 0687-SO-097 GS-88-01 001022-0001	SP14-02 30'-31.5' 0687-SO-097 GS-88-02 001022-0002
2-Butanone	Method 8240	mg/kg	2,500			0.25
Dissolved Lead	239.2	mg/L	0.05			
EDB (1,2-Dibromoethane)	METHOD 504	ug/L		0.046		
LEAD	239.1	mg/kg	70			
MOISTURE	GRAV.	%				
OIL & GREASE	413.2	mg/L				
Recoverable Lead	239.2	mg/L	0.05			
Total Dissolved Solids	160.1	mg/L	500			
Total Petroleum Hydrocarbons	3550/418.1 Mod.					
Total Solids	160.3	%			75.9	84.0

4.2.17.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis were lost from Site SP-14; however, the water samples originally submitted to the laboratory for EDB analyses were not analyzed due to laboratory oversight. Holding times were exceeded by the time the laboratory realized the oversight, and the analyses were not performed.

4.2.17.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is possible, but unlikely, that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures and cross-contamination were detected in samples from the site.

4.2.17.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Four soil samples were collected from 2 boreholes drilled at the site. The boreholes were completed as monitoring wells, and these wells were sampled along with 2 previously existing wells. The water samples, which were to be tested for dissolved metals, were not originally filtered in the field. This was corrected by resampling the 4 wells for dissolved metals only, and filtering the samples onsite prior to shipment.

4.2.17.2.4 Corrective Actions Applied to Out-of-Control Events, Including a Chronology of Rerunning Samples and Controls

All 4 wells at Site SP-14 were resampled for dissolved metals. The following table shows when sampling and resampling activities were conducted.

Well Number	Original Sampling Date	Resampling Date
SP14-01	8/11/88	8/24/88
SP14-02	8/11/88	8/24/88
W-17	8/11/88	8/24/88
GW-7A	8/11/88	8/24/88

Each of the 4 wells was resampled for EDB on February 28, 1989.

4.2.17.3 Significance of Findings

Analytical methods detected petroleum hydrocarbons in subsurface soil and EDB and lead were detected in groundwater samples from Site SP-14. Dissolved lead levels detected in groundwater at the site exceeded its MCL of 0.05 mg/L. Petroleum hydrocarbon concentration of 3.5 mg/L was detected in groundwater samples from well GW-7A in a 1986 sampling effort (Dames and Moore, 1987). Petroleum hydrocarbons were not detected in water samples collected during the 1988 field investigation. EDB was detected at concentrations of 0.035 ug/L and 0.046 ug/L from well W-17 and well SP14-02, respectively. A maximum contaminant level does not exist for EDB; however, EDB in drinking water is of concern because of its associated cancer risk factor.

The probable source of petroleum hydrocarbons in the soil and EDB and dissolved lead in the water at this site is a MOGAS spill of 1500 gallons that occurred in 1965 at the site.

Pathways of exposure are contact with and ingestion or uptake of the contaminated groundwater. Receptors of the contamination are humans, wildlife, and plants. Exposure to the contaminated subsurface soil is unlikely due to the depth (approximately 30 feet).

4.2.17.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. A soil gas survey at Site SP-14 showed detectable BTX and unidentified organics contamination throughout the area (Figure 4.2.17.4, Table 4.2.17.1). This contamination was also detected by HNu equipment in the field during drilling of well SP14-01. Laboratory analysis confirmed the presence of petroleum hydrocarbons at the 30-foot depth in this boring. Analyses also showed contamination by 2-butanone in subsurface soil at well SP14-02. General concentration lines have been constructed for the soil gas data, but there is insufficient data from other sources to allow three-dimensional temporal or higher-definition spatial mapping.

Water samples analyzed from well SP14-02 completed as part of this study and from well W-17 installed previously did indicate contamination by EDB. Lead was detected in water samples from all 4 of the wells at Site SP-14.

4.2.17.3.2 Contaminant Migration

Lead is migrating in the groundwater, as evidenced by the higher concentrations of this metal in downgradient wells including well GW-7A and well SP14-01 at Site SP-14. EDB was detected in well W-17 and well SP14-02 but not in well GW-7A or well SP14-01 (both of which are within about 200 feet of and downgradient of well W-17). The concentration of EDB in well SP14-02 (which is more than 700 feet removed from W-17) is slightly higher than that in well W-17. Although the boundaries of the site have not been clearly identified,

past reports indicate that the spill occurred near the intersection of "P" and 36th Streets (Phase II Stage 2 Report, Dames and Moore 1988).

This is the present location of well W-17. Both wells GW-7A and SP14-01 are located downgradient of this point. The soil gas survey also showed contamination in an area at the corner of "P" and 2nd Streets. This area is not directly downgradient from the reported spill site (Figure 4.2.17.4); however, flow directions may change seasonally, making this area downgradient from the actual spill site at different times of the year. Alternatively, the contamination may be due to some other spill or leak.

4.2.17.3.2.1 Potential for Offsite and Off-Base Migration

Offsite migration of contaminant has occurred at Site SP-14 as evidenced by contamination in three offsite wells. In addition, a soil gas survey showed contamination by BTX and unidentified organics to encompass an area spreading both north and south of the original spill site.

4.2.17.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site inferred that the direction of groundwater flow is to the south-southwest with a gradient of about 60 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to

temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of the migration rate of the dissolved chemicals.

4.2.17.3.2.3 Time of Travel to Receptors

The primary receptors at present are humans, wildlife, fish and plants. Primary pathways are ingestion and handling of contaminated ground and surface water and plants. Ship Creek is located about 2000 feet southwest of Site SP-14. Hydraulic conductivity values have not been established for this site; thus, time of travel to the creek cannot be determined. Any contamination reaching the creek is expected to become highly diluted within its waters.

An active drinking water well, base well 52, is about 4000 feet downgradient of the site at building 23-100. This well was sampled as part of this investigation (Section 4.2.24). Time of travel to the well cannot be determined until hydraulic conductivity values have been established. However, base well 52 is an artesian well, drilled to a depth of 166 feet (Phase II, Stage 2 Report, Dames and Moore 1988). The water from base well 52 is contained inside a casing as it flows through the zone of contamination detected at Site SP-14, and is unlikely to be affected by impacts from the site unless the seal within the confining layer leaks.

4.2.17.3.2.4 Expected Spatial and Temporal Variations in Concentration

Contamination was not detected in any of the surface soil samples collected at the site and analyzed by the laboratory. Organic contaminants were detected in soil samples from the 30-foot depth of well SP14-01 and SP14-02 at Site SP-14.

A soil gas survey detected contamination by BTX and unidentified organics encompassing an area that reached about 400 feet north, south and west of the original spill. The soil gas survey also detected contamination 700 feet directly south of the spill site, where well SP14-02 was subsequently drilled.

The spatial extent of contamination in groundwater reaches at least to well GW-7A, which is about 200 feet from what is estimated to be the spill site. Contamination detected in well SP14-02, located about 700 feet directly south of the spill site, may or may not be due to fuel spill. Groundwater flow direction was predicted to be in a south-southwest direction, however, seasonal and temporal effects may alter the direction of flow.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of the contaminants is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.17.3.3 Baseline Risk Assessment

The following sections evaluate the contamination in relation to exposure routes, receptors, and health effects.

4.2.17.3.3.1 Waste Characterization

The primary wastes at the site are petroleum hydrocarbons, lead, and EDB. Total petroleum hydrocarbons were detected in the northernmost soil samples collected at Site SP-14. One specific type of hydrocarbon, 2-butanone, was detected in 1 soil sample. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects. EDB, which was detected in water samples from 2

wells, has an associated cancer risk and at substantially higher concentrations can affect the central nervous system, respiratory tract, liver, kidneys, skin and eyes. Lead was detected only in water samples. Several of these concentrations exceeded State of Alaska and federal limits for the metal. The source of lead at this site is mostly likely from its use as a gasoline additive. Exposure to this metal can affect the central nervous and circulatory systems.

4.2.17.3.3.2 Source and Release Characterization

Petroleum hydrocarbons, EDB and lead were released to the environment most likely as the result of a motor-gas (MOGAS) spill. Approximately 1500 gallons of fuel were spilled and none was recovered.

4.2.17.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons released to the environment at Site SP-14 includes long-term natural degradation, taking excess of 100 years, dispersion of the contaminants through runoff, or uptake by living organisms. Another possible fate is the volatilization of petroleum fractions that have vapor pressure (v.p.) greater than 1 mm of mercury. The fate of the EDB is similar to that of the petroleum hydrocarbons. The fate of lead in the environment includes oxidation, uptake by organisms and/or chelation with organics, water, or cations such as Cl- and OH-.

Dissolved contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration with the groundwater through the process of advection. Additional transport can occur in the form of surface runoff or release of vapor to the atmosphere. Finally, contaminated soil or water from the site can be transported through human intervention.

4.2.17.3.3.4 Exposure Pathways

At present, the exposure pathway for humans, fish and wildlife is contact with or ingestion of contaminated ground or surface water, fish or plants.

4.2.17.3.3.5 Identification of Receptors

Receptors are humans, fish, wildlife, and plants. Human receptors include anyone drinking from base well 52. In addition, humans may be exposed to contamination through fish from Ship Creek. Plants in the contaminated area are less likely to become contaminated since surface and near-surface soils have not been shown to be contaminated. Lawn-type grass covers the vicinity of the spill site. This vegetation type is unlikely to contact contaminated groundwater.

4.2.17.3.3.6 Threat to Human Health

A possible threat to human health is the drinking of water from base well 52. Base well 52 was sampled as part of this investigation (Section 4.2.24). The sample was found to contain petroleum hydrocarbons (2.0 mg/L), but no lead. EDB analyses were not performed on this well. Due to the low toxicity of petroleum hydrocarbons, and the design of the well, any threat to human health from drinking water from base well 52 is assessed as low.

Another threat to human health is the drinking of Ship Creek water, or the ingestion of fish from Ship Creek. As part of this study, water and sediments were collected and analyzed from a point on Ship Creek, southwest and downgradient from Site SP-14 (Section 4.2.23). The samples did not contain lead or petroleum hydrocarbons above method detection limits. The threat to human health from exposure to Ship Creek water is minimal to nonexistent.

4.2.17.3.3.7 Carcinogenic Risks

EDB in groundwater was the only carcinogenic compound detected by the analyses performed on soil and water samples from Site SP-14, and it was detected in only 2 of the 4 wells tested. EDB is an EPA Category Group B2 (probable human) carcinogen which means there is sufficient evidence of carcinogenicity in animals but inadequate evidence of carcinogenicity in humans.

4.2.17.3.3.8 Threat to Wildlife

Threat to wildlife is possible through ingestion of contaminated surface waters. Ship Creek constitutes the nearest surface water body. The threat is minimal to nonexistent due to the distance of the site from the surface water of Ship Creek, the high dilution rate of creek water, and the fact that this study found creek water and sediments to be uncontaminated.

4.2.17.3.3.9 No Threat to Health

Groundwater samples collected in 1988 were not contaminated above State of Alaska primary standards for organic compounds. The EDB detected had an associated excess cancer risk factor higher than the 10^{-6} value cited by ADEC as a level of regulatory concern. Lead was detected at levels exceeding the State of Alaska standards of 0.05 mg/L by up to 0.016 mg/L. Lead is considered to be environmentally persistent and toxic. Receptors and pathways of exposure are present. However, due to the distance of the site from downgradient wells and/or surface water and the resulting dilution of the contaminants, the duration and frequency of exposure to receptors is not expected to be sufficient to cause adverse health effects.

4.2.17.4. Prioritization of Sites for Remedial Alternatives

The site has been adequately characterized by the installation and sampling of 4 groundwater monitoring wells. The soil gas survey showed the placement of the wells to be in position to sample the contaminated areas. Groundwater samples from these wells were not contaminated at levels above primary State of Alaska standards for petroleum hydrocarbons, but did slightly exceed standards for lead. Also, the cancer risk factor exceeded the value cited by ADEC as a level of concern. However, release mechanisms and migration pathways to receptor exposure have not been shown to be significant. Site SP-14 is assigned to no further action status.

4.2.18 Discussion of Results for Site SP-15, AVGAS Spill

A 1,000 gallon aviation gasoline (AVGAS) spill occurred at Site SP-15 in 1961 (Figure 4.2.18.1). The majority of the spill was contained and collected; however, some of the fuel seeped into the ground.

4.2.18.1 Presentation of Results for Site SP-15

Results of the geologic and hydrogeologic investigations are presented in the following sections. Analytical results are tabulated and presented on the site location maps.

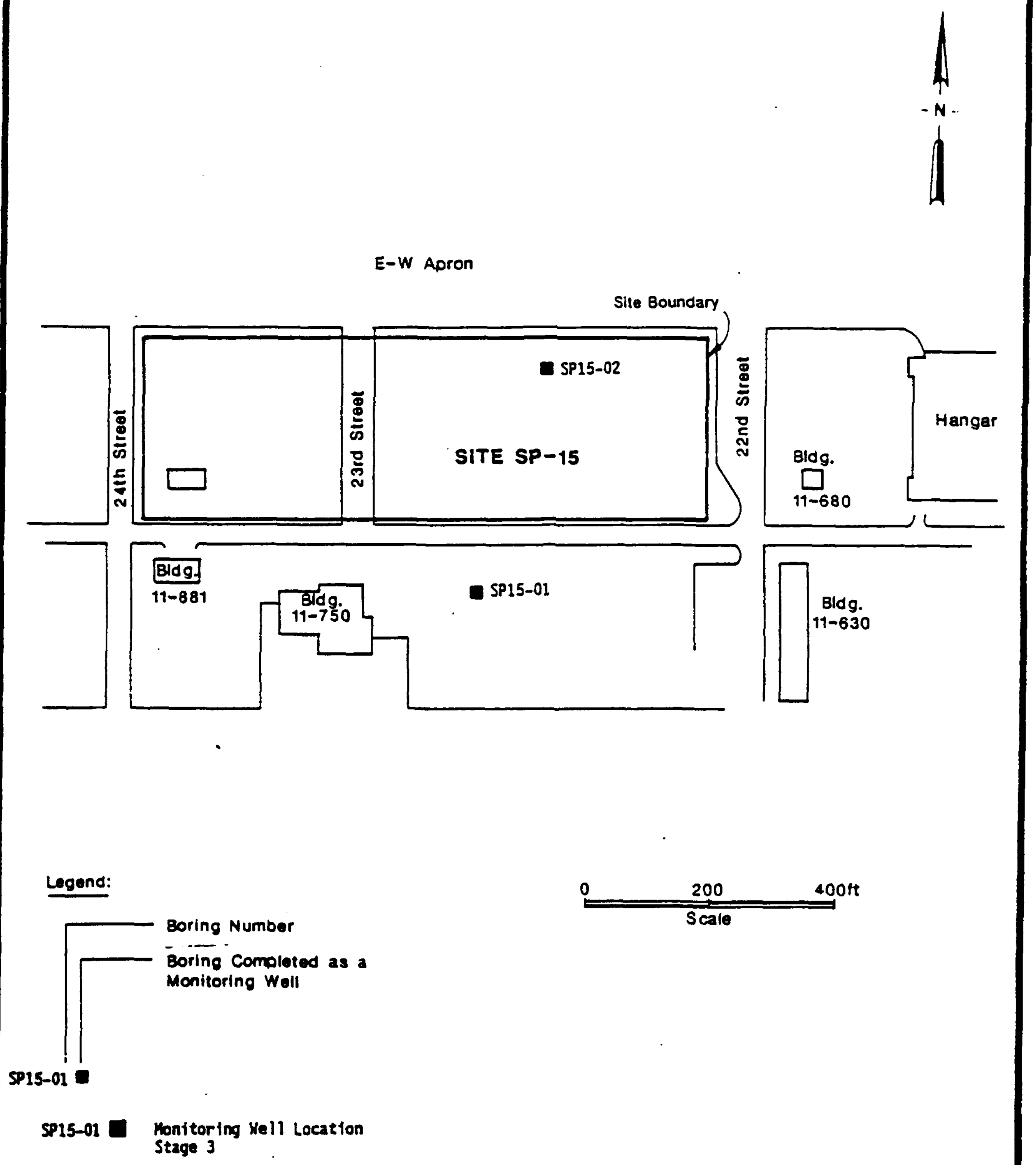
4.2.18.1.1 Site Geology

The SP-15 site is located at an elevation of 185 feet on flat terrain and is underlain by late-Quaternary glacial outwash deposits consisting chiefly of coarse-grained sandy gravel. The site surface has been cleared and graded, and currently is planted with grass or paved.

Two borings were drilled, sampled and converted to monitoring wells. Both borings encountered well-graded sandy gravel. Logs of the borings are provided in Appendix C. An interpreted gamma log of well SP15-01 is shown in Appendix D. A geologic cross section of the site is provided in Figure 4.2.18.2.

4.2.18.1.2 Site Hydrogeology

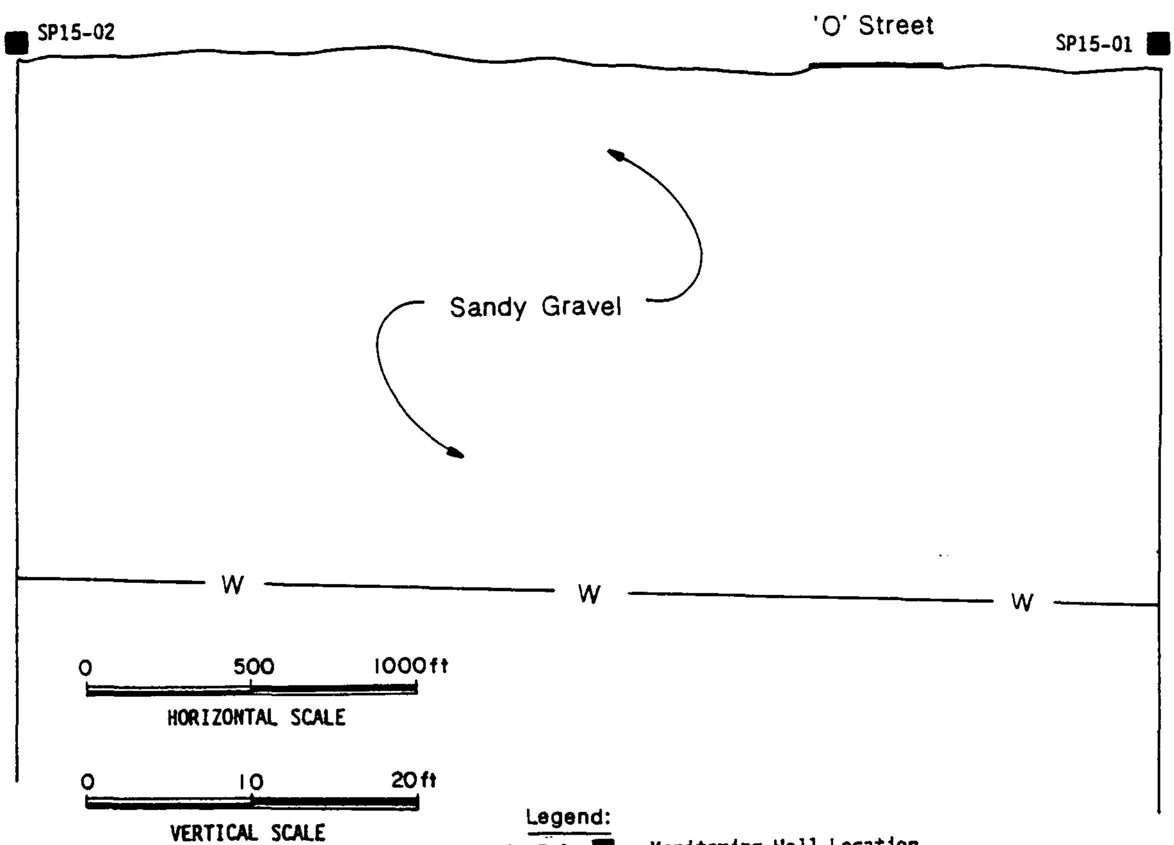
Site SP-15 is underlain by coarse-grained sandy gravels with a water table depth of approximately 25 to 30 feet. The direction of groundwater flow is based on a comparison of regional trends with water-level measurements at 2 wells at the site (Figure 4.2.18.3).



LOCATION MAP
SITE SP-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.18.1



Legend:

SP15-01 ■ Monitoring Well Location Stage 3

—W— Projected Water Table

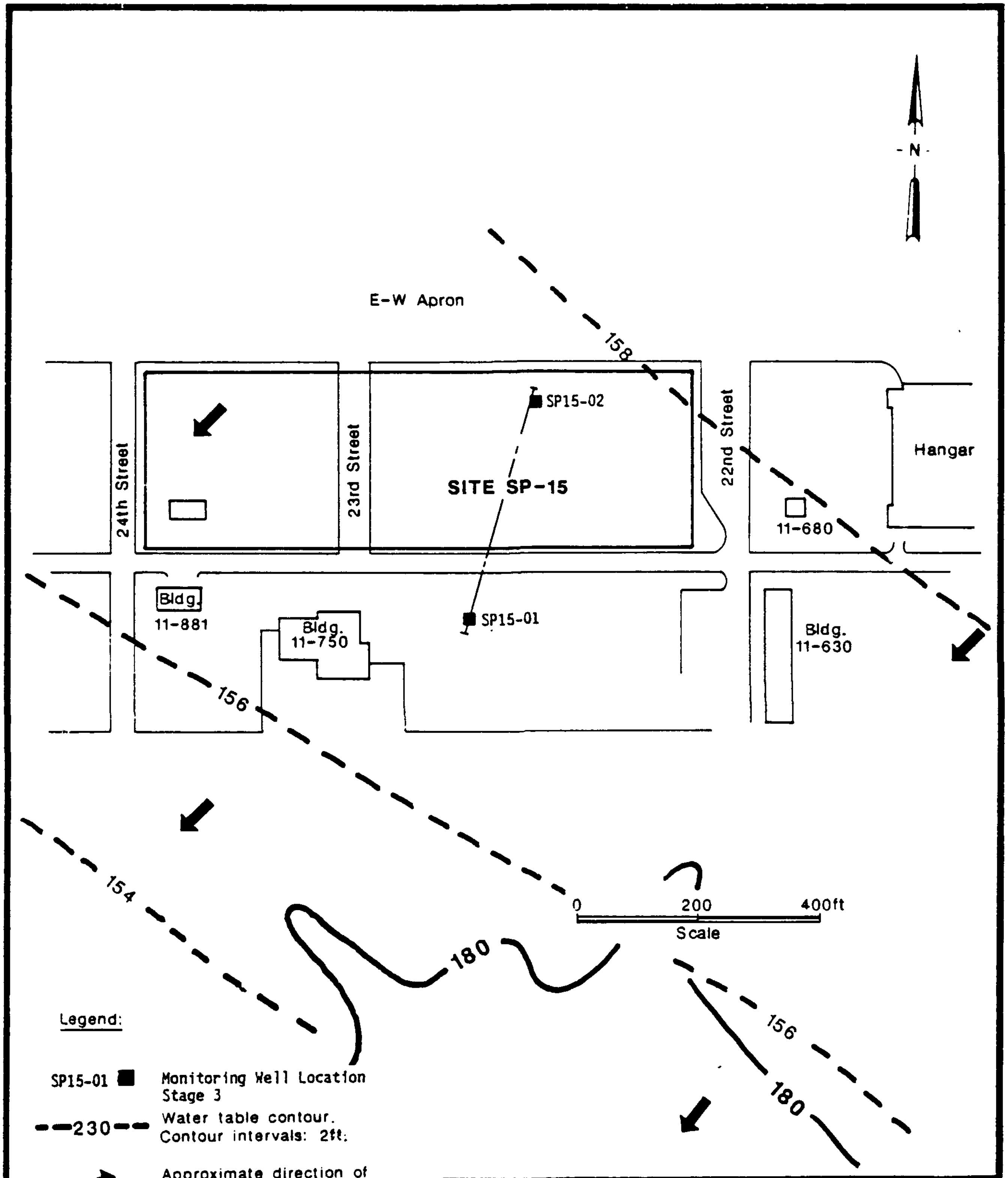
Notes:

1. Horizontal scale: 1 inch = 500 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Cross section location shown on Figure 4.2.18.3

GEOLOGIC CROSS SECTION
SITE SP-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.18.2



HYDROGEOLOGIC MAP
SITE SP-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.18.3

The direction of groundwater flow is southwest with a gradient of approximately 15 feet per mile. Hydraulic conductivity values have not been determined for this site.

4.2.18.1.3 Analytical Results

Field analytical results and observations and laboratory analytical results are discussed in the following sections.

4.2.18.1.3.1 Field Analytical Results and Observations

Results of a soil gas survey conducted at Site SP-15 are presented on Figure 4.2.18.4 and in Table 4.2.18.1. Isoconcentration contours have been drawn based on the findings of the field analysis. In addition to the soil gas survey, visual observations were made at the subsurface investigative sites. The following evidence of contamination was recorded:

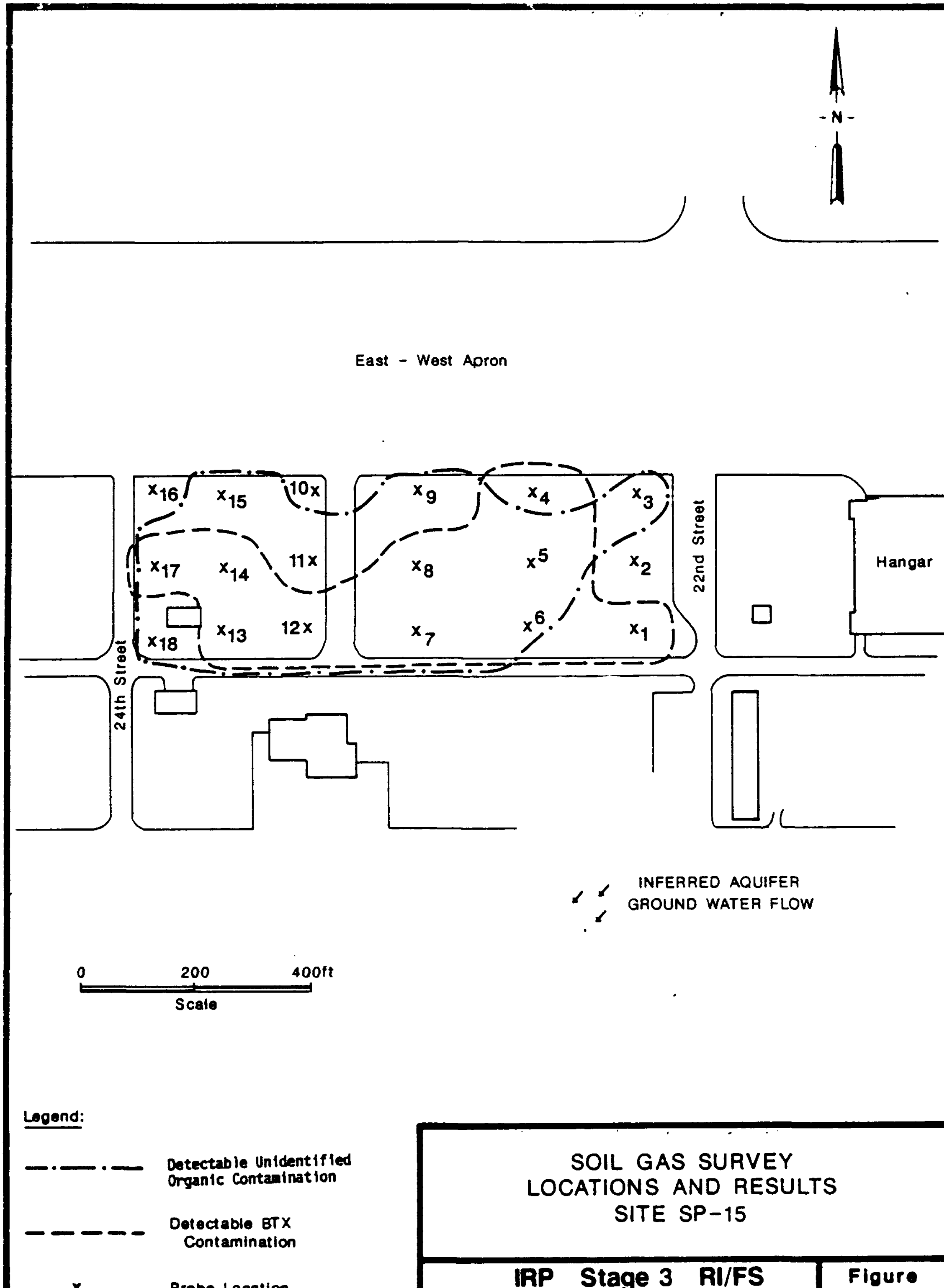
Well SP15-01 - HNu readings of soil samples from depths:
5 feet - 40 ppm
20 feet - 4 ppm
25 feet - 120 ppm
30 feet - 2 ppm

Well SP15-02 - An HNu reading of 5 ppm was recorded in a soil sample taken at 30 feet (below the water table) in sandy gravel sample

Field parameters measured at SP-15 during groundwater sampling are presented in Table 4.2.18.2.

4.2.18.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site SP-15 is presented on Table 4.2.18.3, and the sample plan for the base-wide field investigation



SOIL GAS SURVEY
LOCATIONS AND RESULTS
SITE SP-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.18.4

Table 4.2.18.1 Summary of Soil Gas Chromatograph Analyses at Site SP-15

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)	Comments
1	5	-	1.43	TR	-	Unidentified Organics are at 1.10 RT
2	10	-	TR	-	TR	
3	5	-	TR	TR	.33	
	6.5	-	.35	TR	.06	
4	7	-	.43	TR	-	
5	10	-	.43	TR	.14	
6	7.5	-	1.57	TR	.18	
7	7	-	.48	-	.09	
8	8	-	.32	-	.10	
9	8.5	-	TR	TR	.37	
10	6.5	-	-	-	-	
11	6.5	-	TR	TR	.06	
12	7.5	-	.42	-	.07	
13	8.5	.55	-	-	.41	
14	6	-	.17	TR	.17	
15	8.5	-	TR	TR	.12	
16	7	-	TR	-	TR	
17	8	-	.05	-	.25	
18	10	-	TR	-	.42	

Note: Unidentified organics are reported in benzene equivalent ppm.
TR - Trace.
RT - Retention Time

Table 4.2.18.2 Field Parameters Site SP-15

Well No.	Date Sampled	Temperature (C)	Conductivity (mhos/cm)	pH	Alkalinity mg/L	Appearance
SP-15-01	8/22/88	7.0	650	7.21	244	Slight odor, sheen
SP-15-02	8/22/88	7.0	800	7.02	168	No odor or sheen

Table 4.2.18.3 Requested Analyses for Laboratory Samples at Site SP-15

SOIL

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
6010	Lead
8240	Volatile Organic Compounds
160.3	Soil Moisture Content

WATER

Test Number	Analysis
418.1	Petroleum Hydrocarbons
1239.2	Lead (total and dissolved)
SW602	Purgeable Aromatics

program is included in Appendix B. Major organic contaminants identified from the laboratory analysis of samples collected at Site SP-15 are plotted in Figures 4.2.18.5 through 4.2.18.9. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well or test boring. Sampling depth is included for the soil samples. Isoconcentration lines were not drawn due to the few points having detectable contamination for each analyte. Results of analytical tests for metals and other contaminants are presented on Table 4.2.18.4.

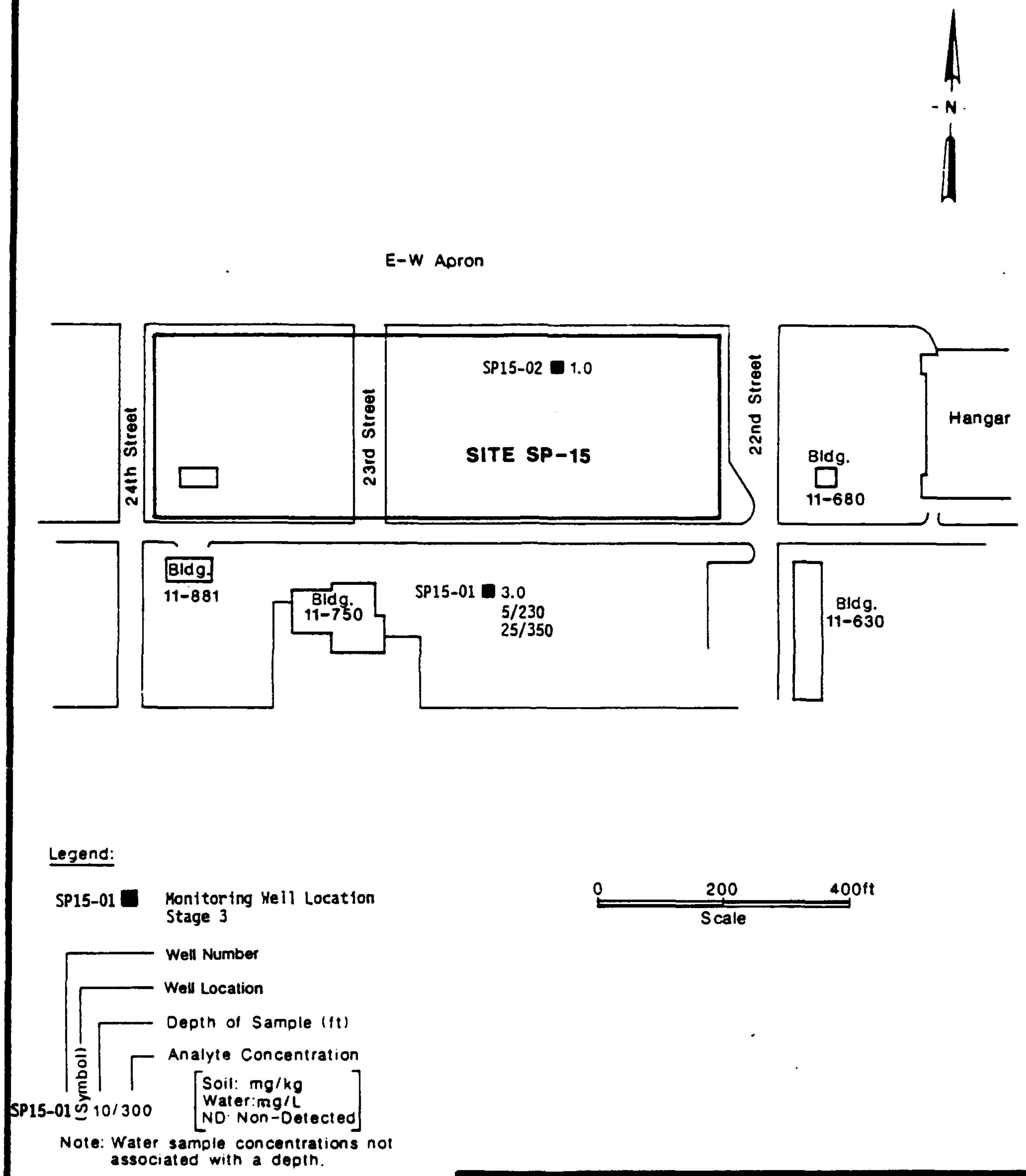
4.2.18.1.4 Analytical Results Table

All of the laboratory analytical results for Site SP-15 are presented on Table 4.2.18.4.

4.2.18.1.5 Discussion of Analytical Data

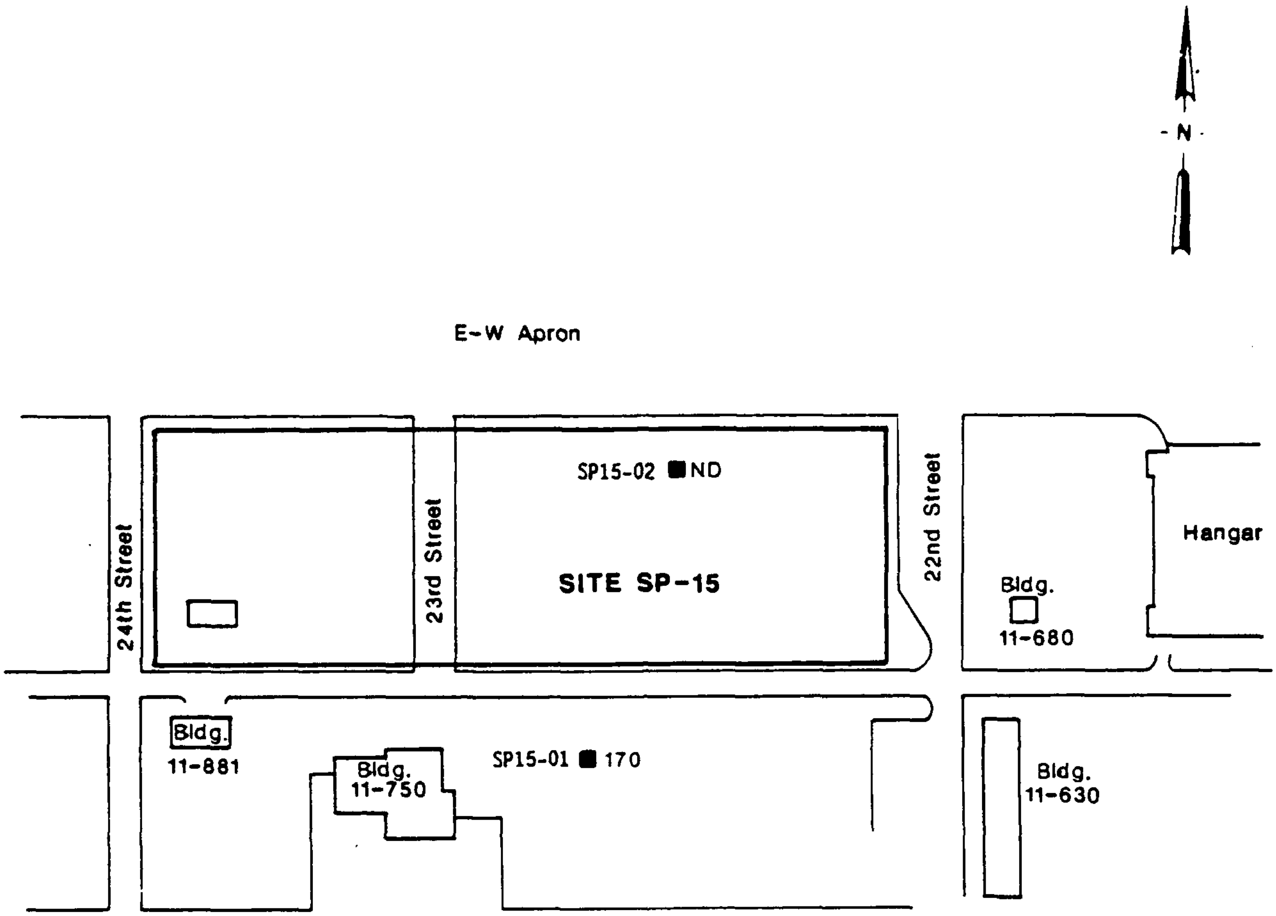
Volatile organic compounds, specifically benzene, ethylbenzene, toluene, and xylenes (BETX) were detected in samples taken at Site SP-15. However, most of the contamination was limited to well SP15-01 (Figures 4.2.18.6 through 4.2.18.9). Total BETX concentration in a water sample taken from well SP15-01 was 980 ug/L. A soil sample taken from 25 feet during drilling of this well contained toluene (13 mg/kg), ethylbenzene (21 mg/kg), and total xylenes (91 mg/kg). Total petroleum hydrocarbon concentrations were 3.0 and 1.0 mg/L for water samples from wells SP15-01 and SP15-02, respectively. Soil samples from 5 and 25 feet in well SP15-01 contained total petroleum hydrocarbon concentrations of 230 and 350 mg/kg, respectively.

Lead was detected in a soil sample from 5 feet deep in well SP15-01 at a concentration of 72 mg/kg. Total recoverable lead was also detected in water from this well at a level of 0.027 mg/L. A soil sample from 5 feet in well SP15-02 also contained lead (21 mg/kg). The water



TOTAL PETROLEUM HYDROCARBON
CONCENTRATION
SITE SP-15

IRP Stage 3 RI/FS **Elmendorf AFB, AK**	**Figure** 4.2.18.5



Legend:

SP15-01 Monitoring Well Location Stage 3

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration

SP15-01 (Symbol) 10/300

[Soil: mg/kg
Water: µg/L
ND Non-Detected]

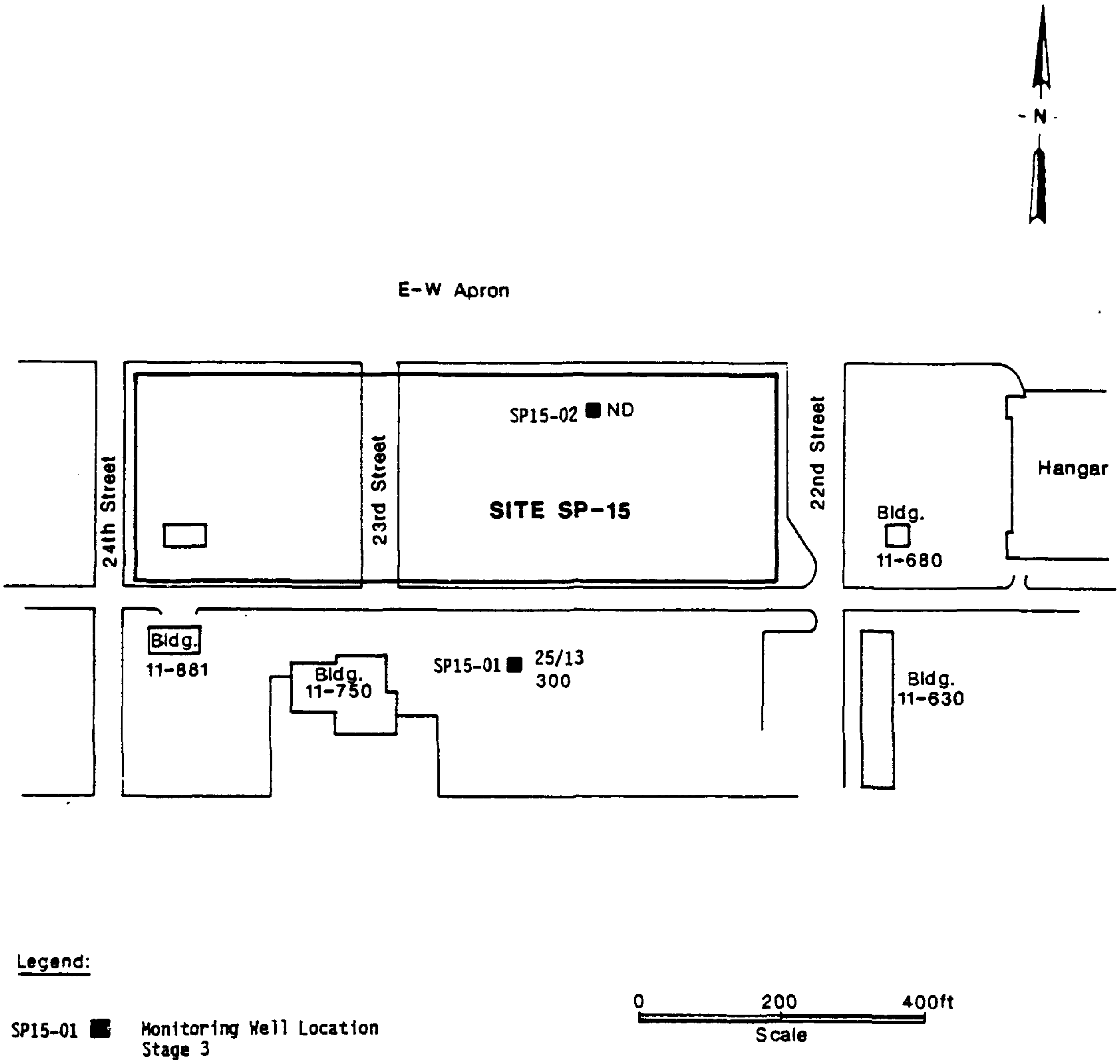
0 200 400ft
Scale

Note: Water sample concentrations not associated with a depth.

BENZENE CONCENTRATION
SITE SP-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.18.6



Legend:

SP15-01 ■ Monitoring Well Location Stage 3

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration

SP15-01 (Symbol) 10/300

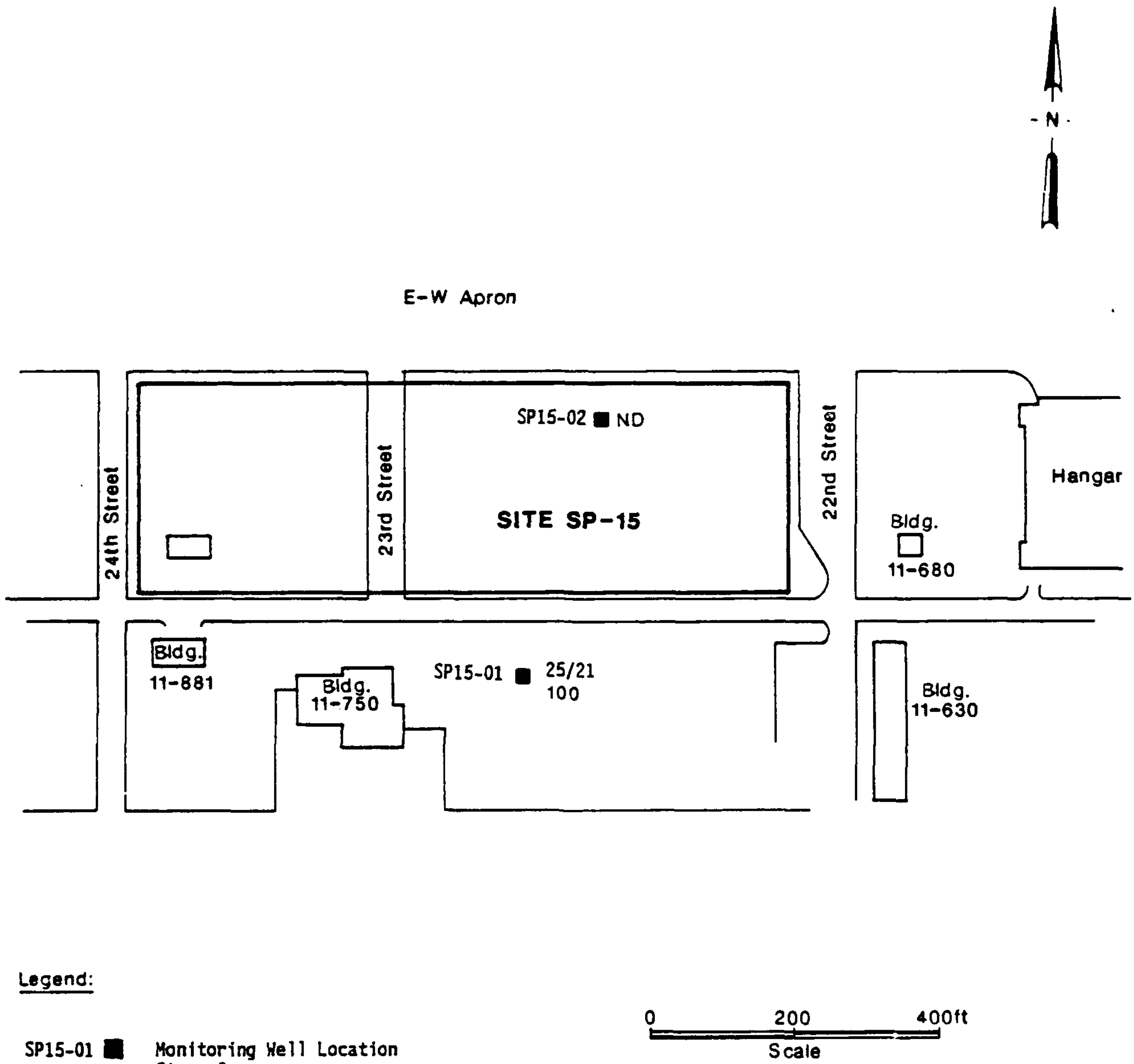
[Soil: mg/kg
Water: µg/L
ND Non-Detected]

Note: Water sample concentrations not associated with a depth.

TOLUENE CONCENTRATION
SITE SP-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.18.7



Legend:

SP15-01 ■ Monitoring Well Location Stage 3

- Well Number
- Well Location
- Depth of Sample (ft)
- Analyte Concentration

SP15-01 (Symbol) 10/300

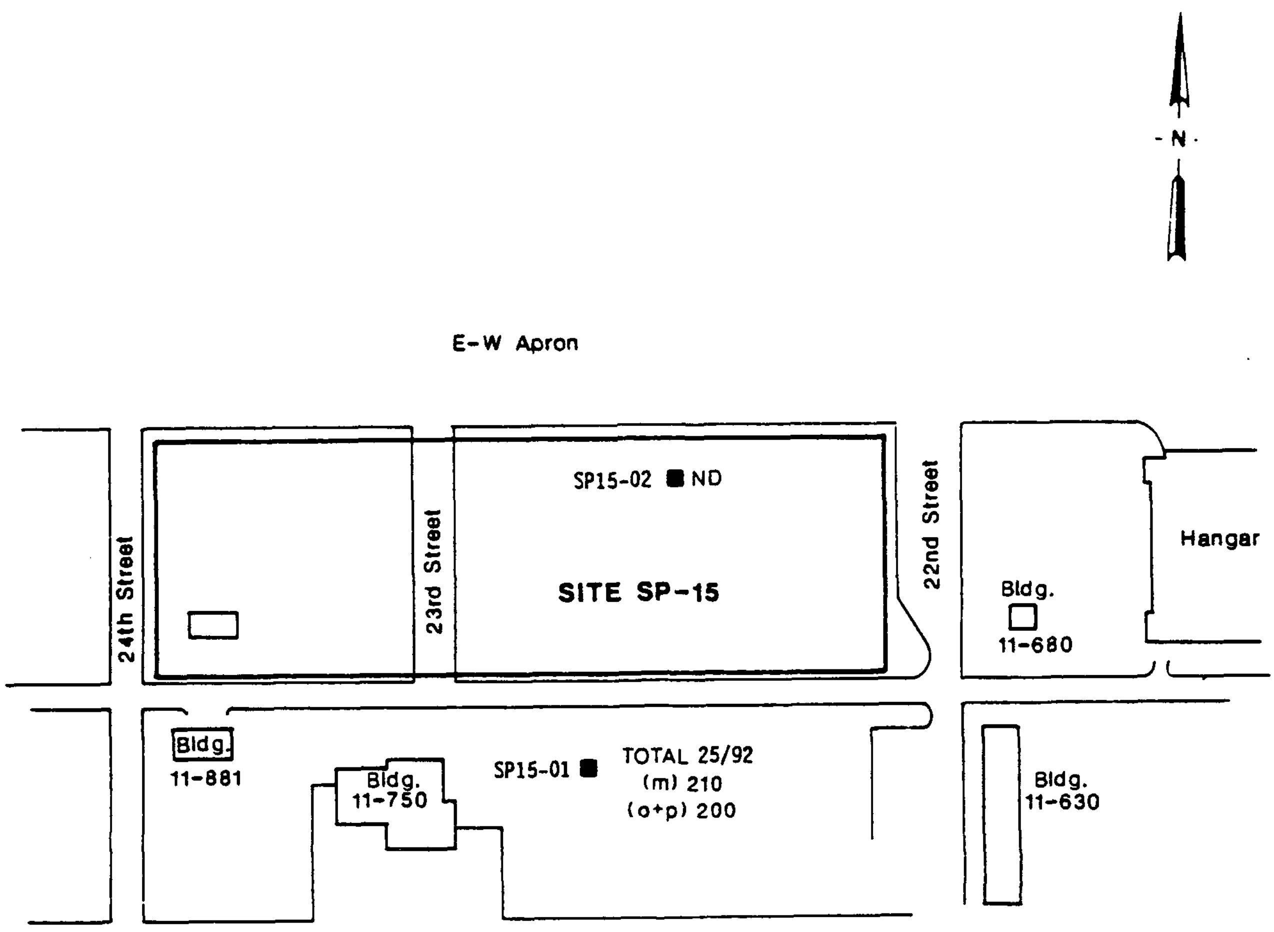
[Soil: mg/kg
Water: µg/L
ND: Non-Detected]

Note: Water sample concentrations not associated with a depth.

ETHYL BENZENE CONCENTRATION
SITE SP-15

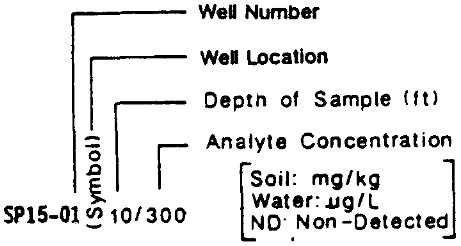
IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.18.8



Legend:

SP15-01 ■ Monitoring Well Location
Stage 3



Note: Water sample concentrations not associated with a depth.

0 200 400ft
Scale

(m), (o+p) AND TOTAL XYLENE CONCENTRATION
SITE SP-15

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.18.9

Table 4.2.18.4

Analytical Results - Site SP-15

Parameter	Method	Units	Standards, Criteria and Action Levels Federal\State	SP15-02 0687-NG-101 GW-88-0003 001347-0006	SP15-02 DUPLICATE 0687-NG-101 GW-88-0003D 001347-0006	SP15-01 0687-NG-100 GW-88-0003 001347-0005	SP15-01 5'-6.5' 0687-SO-100 GS-88-01 000837-0001	SP15-01 25'-26.5' 0687-SO-100 GS-88-02 000837-0002
Benzene	EPA 602	ug/L	5.0			170.		
Ethyl benzene	EPA 602	ug/L	700			100.		21
Lead	239.1	mg/kg	70				72	
Recoverable Lead	239.2	mg/L	0.05	0.12	0.11	0.027		
Toluene	EPA 602	ug/L	2000			300.		13
Total Dissolved Solids	160.1	mg/L	500					
Total Petroleum Hydrocarbons	EPA 418.1			1.0	2.0	3.0	227	351
Total Solids	160.3	%					97.1	94.0
Total xylenes	Method 8240	mg/kg	500					91
m-Xylene	EPA 602	ug/L	440			210.		
o & p-Xylene(s)	EPA 602	ug/L	440			200.		

sample (0.12 mg/L) from SP15-02 contained total recoverable lead. Dissolved lead was not detected in the groundwater at this site.

4.2.18.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site SP-15 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.18.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis were lost from Site SP-15.

4.2.18.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is possible, but unlikely, that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in samples from the site.

4.2.18.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Four soil samples were collected from 2 borings at Site SP-15. The borings were completed as monitoring wells and 1 water sample was collected from each well. Well SP15-02 was originally completed with a 3-foot, above-ground completion. Due to its proximity to the runway, this configuration was later changed to a flush-mount in order to comply with the statement of work and base regulations.

4.2.18.2.4 Corrective Actions Applied to Out-of-Control Events, Including a Chronology of Rerunning Samples and Controls

A jackhammer was used to remove a concrete pad around the original well SP15-02. The PVC was cut to just below ground level and a valve box was fitted over the exposed well. The well was capped during this operation and no contaminants were introduced into the well. No other corrective actions occurred at Site SP-15, and no samples were rerun.

4.2.18.3 Significance of Findings

Analytical methods detected volatile organic compounds and total recoverable lead in soil and water samples from Site SP-15. Benzene was detected in water from well SP15-01 at a level exceeding the State of Alaska Primary Drinking Water Standards. Water samples from both wells at the site exceeded State of Alaska Secondary Drinking Water Standards for total dissolved solids. Total recoverable lead concentrations exceeded the MCL of 50 ug/L at SP15-02. Total dissolved lead was not detected in the groundwater. For the reasons explained in Section 4.1.2, it is anticipated that soil, not lead from the fuel spill, caused the MCL to be exceeded. Total petroleum hydrocarbons were detected at concentrations exceeding the cleanup level suggested by the interim ADEC cleanup guidelines. Petroleum sheen and odor were observed in several soil samples during drilling of both wells. Surface soil samples contained lead at levels less than 100 mg/kg. These are similar to background levels as explained in Section 4.1.2.

The source of petroleum hydrocarbons in the soil and water at this site is an aviation gas (AVGAS) spill of 1000 gallons.

Pathways of exposure are contact with and ingestion or uptake of contaminated ground or surface water. Contact with surface soils contaminated with lead constitutes an additional pathway. Receptors of the contamination are humans, wildlife, fish and plants.

4.2.18.3.1 Zones of Contamination

The data at the site allows for some generalization of the zones of contamination. A soil gas survey at Site SP-15 indicated detectable BTX and unidentified organic contamination throughout the area north of "O" Street and between 24th and 22nd Streets. Field observations showed an HNu reading of 5 ppm at 30 feet in well SP15-02. Laboratory analyses did not confirm the soil gas and HNu readings; no petroleum hydrocarbons were detected in soil samples from well SP15-02.

The soil gas survey did not extend to the area south of "O" Street (Figure 4.1.18.4). Well SP15-01 at Site SP-15 was installed in this area which is off-site and downgradient of Site SP-15. HNu readings were detected at a depth of 5 feet and from 20 through 25 feet, with the highest reading of 120 ppm recorded at the 25 foot depth. Laboratory analyses confirmed the presence of petroleum hydrocarbons at the 5 and 25 foot depths. General concentration lines have been constructed for the soil gas data, but there is insufficient data from other sources to allow three-dimensional temporal or higher-definition spatial mapping. Water samples from the 2 wells completed as part of this study showed contamination by volatile organic compounds.

4.2.18.3.2 Contaminant Migration

Petroleum hydrocarbons are migrating in the groundwater as evidenced by BETX detected in a water sample from well SP15-01. This well is situated downgradient from the spill, which occurred north of "O" Street (Phase II, Stage 2 Report, Dames and Moore 1987). Total petroleum hydrocarbons were detected in a water sample from the up-gradient well SP15-05, but no BETX was detected in this well.

4.2.18.3.2.1 Potential for Off-Site and Off-Base Migration

Off-site migration of contamination has occurred at Site SP-15 as evidenced by contamination in the downgradient well SP15-01.

Groundwater flow is to the southwest and the nearest base boundary in that direction is approximately 4500 feet distant.

4.2.18.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site indicated that the direction of groundwater flow is to the southwest with a gradient of about 15 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of the migration rate of the dissolved chemicals or aereal extent of contamination.

4.2.18.3.2.3 Time of Travel to Receptors

The primary receptors at present are humans, wildlife, fish and plants. Primary pathways are ingestion of contaminated ground and surface water and handling of contaminated soil. A secondary exposure route would be the ingestion of contaminated plants or fish. Ship Creek is located about 4000 feet southwest of Site SP-15. Hydraulic conductivity values have not been established for this site; thus, time of travel to the creek cannot be determined.

Base well 40, an active drinking water source is located about 2000 feet downgradient of the site at building 5-800. Time of travel to the well cannot be determined until groundwater migration rates have been established. Base well 40 at Site SP-15 is an artesian well,

drilled to a depth of 209 feet (Phase II, Stage 2 Report, Dames and Moore 1987). The water from the well is contained inside a casing as it flows through the zone of contamination detected at SP-15 and is unlikely to be affected by impacts from the site.

4.2.18.3.2.4 Applicability of Solute Transport Models

Solute transport models may be important at Site SP-15. Wells installed to the south and southwest of the site may provide additional hydrogeological data and allow the formation of more accurate solute transport models. The results of this modeling would help to determine the potential risk to down gradient we er supplies and surface water.

4.2.18.3.2.5 Expected Spatial and Temporal Variations in Concentration

A soil gas survey detected contamination by BTX and solvents encompassing an area of about 5 acres. The actual location of the spill is not known; therefore, it cannot be determined if any of this area is up gradient of the spill.

The spatial extent of contamination in groundwater reaches at least to well SP15-01, which is about 100 feet downgradient of the edge of the soil gas survey. Since the location of the spill is not known, contamination detected in well SP15-02 may or may not be due to down gradient flow of contaminated groundwater. Groundwater flow direction was predicted to be in a southwest direction; however, seasonal and temporal effects may alter the direction of flow.

Volatile organic contaminants and TPH were detected at greater concentrations in soil and groundwater samples in well SP15-01 than at SP15-02.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of the contaminants is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.18.3.3 Baseline Risk Assessment

Contamination in relation to exposure routes, receptors, and health effects are evaluated in the following sections.

4.2.18.3.3.1 Waste Characterization

The primary wastes at the site are petroleum hydrocarbons and purgeable aromatics (BETX). Total petroleum hydrocarbons were detected in soil and water samples at Site SP-15. BETX was detected in soil and groundwater samples from well SP15-01. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects. BETX compounds can be highly toxic and 1, benzene, is known to cause cancer. Both petroleum hydrocarbons and BETX compounds are commonly associated with fuel spills.

4.2.18.3.3.2 Source and Release Characterization

Petroleum hydrocarbons including the BETX fraction were released to the environment as the result of an AVGAS spill. Approximately 1000 gallons of fuel were spilled in 1961. The majority of the spilled fuel was recovered, but some did seep into the ground.

4.2.18.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons released to the environment at Site SP-15 includes long-term natural degradation, taking in excess of 100 years, dispersion of the contaminants through runoff, or uptake by

living organisms. Another possible fate is the volatilization of petroleum fractions that have vapor pressures greater than 1 mm of Hg (e.g., benzene vapor pressure = 100 at 26.1 C).

Dissolved contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration with the groundwater through the process of advection. Additional transport can occur in the form of surface run-off or release of vapor to the atmosphere. Contaminated soil or water from the site can be transported through human intervention.

4.2.18.3.3.4 Exposure Pathways

At present, the exposure pathway for humans, fish and wildlife is contact with or ingestion of contaminated ground or surface water, fish or plants. Another pathway is the contact with or handling of contaminated soils.

4.2.18.3.3.5 Identification of Receptors

Receptors are humans, fish, wildlife, and plants. Human receptors include anyone drinking from base well 40, ingesting water and fish from Ship Creek, or handling contaminated soils. Plants in the area may also become contaminated since surface and near-surface soils are contaminated with petroleum hydrocarbons.

4.2.18.3.3.6 Threat to Human Health

A possible threat to human health is the drinking of water from base well 40. Base well 40 was last sampled for volatile organics in September of 1988 (personal communication, TSGT Sudabeck USAF, 1989). The sample contained 3.3 ug/L of chloroform. The EPA MCL for this compound is 100 ug/L. Samples collected in June and March of 1988 did

not contain volatile organic compounds above the method detection limits. The Air Force has scheduled this well for quarterly testing for volatile organic compounds. Chloroform was not detected in soil samples from Site SP-15. Water samples from the site were not analyzed for purgeable halocarbons.

Another threat to human health is the drinking of Ship Creek water or the ingestion of fish from Ship Creek. As part of this study, water and sediments were collected and analyzed from points on Ship Creek, southwest and downgradient from Site SP-15. The samples did not contain lead or petroleum hydrocarbons above method detection limits. The threat to human health from exposure to Ship Creek water is minimal.

4.2.18.3.3.7 Carcinogenic Risks

Benzene was detected in a water sample from well SP15-01. The concentration of benzene in the sample was 170 ug/L. This value is 34 times the State of Alaska Primary Drinking Water Standard of 5 ug/L. Benzene is known to cause cancer in humans (Table 4.1.3).

4.2.18.3.3.8 Threat to Wildlife

Threat to wildlife is possible through ingestion of contaminated surface water. Ship Creek constitutes the nearest surface water body. The threat is minimal due to the distance of the site from the surface waters of Ship Creek, the high dilution rate of creek water, and the fact that this study found creek water and sediments to be uncontaminated (Section 4.2.23).

4.2.18.4 Prioritization of Sites for Remedial Alternatives

Concentrations of benzene in a water sample from this site exceeded State of Alaska Primary Water Quality Standards. For this reason and

due to the presence of a downgradient drinking water well, Site SP-15 is a feasibility study site which requires further investigation.

Further work at this site should begin with a soil gas survey in the vicinity of well SP15-01. Data obtained as part of the survey should be used for selecting locations for 3 additional downgradient wells to delineate the contaminant plume. One of the new wells should be located near SP15-01. This well should be screened in the deeper region of the unconfined aquifer. The 2 other wells should be located downgradient of the existing wells. One of these new wells should be a dual completion well, screened in both the upper and lower regions of the aquifer. Data from the deeper region of the aquifer will be used to delineate the vertical extent of contamination. The previously installed and proposed wells should be sampled for petroleum hydrocarbons and volatile organics.

4.2.19 Discussion of Results for Site NS-1, Cherry Hill Ditch

Site NS-1, or Cherry Hill Ditch, is a drainage channel that flows toward the west from the east-west runway to Cook Inlet (Figure 4.1.19.1). The headwaters of the ditch consist of a 30 inch pipe that discharges water at an estimated rate of 200 gallons per minute. The sources of this flow are presumed to be subsurface drains under the runway and building drains. Storm drains from much of the Base, including the runways, discharge to the ditch. There are no known direct industrial discharges to the ditch. Occasional oily sheens and foam have been observed on water flowing through the ditch.

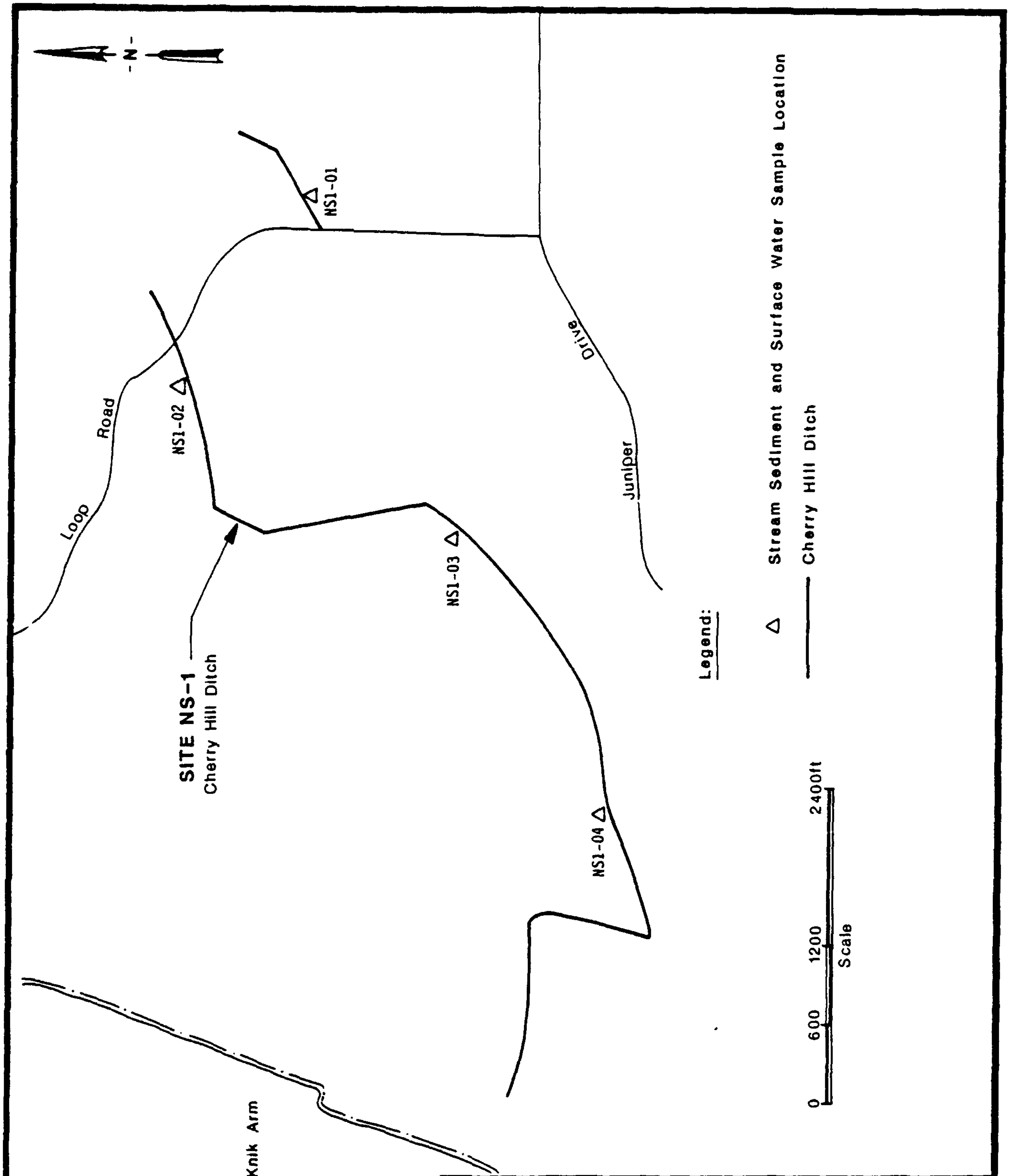
The Alaska Department of Environmental Conservation (ADEC) has issued the Air Force a Notice of Violation for the presence of "large quantities of visible detergents" and indications of the presence of oil and solvents in the ditch (Lamureaux, ADEC, in personal communication to USAF, 26 June 1987). The ADEC requested that the stream sediments be samples for halogenated hydrocarbons.

4.2.19.1 Presentation of Results at Site NS-1

Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site location maps.

4.2.19.1.1 Site Geology

Cherry Hill Ditch is an artificial drainage system on the west side of Elmendorf AFB beginning at an elevation of about 150 feet. The ditch is used to channel near-surface water to the bluff above Knik Arm. The site is underlain by a shallow layer of coarse-grained sand and gravel glacial outwash, typically less than 10 feet thick. The outwash is underlain by the Bootlegger Cove Formation which is composed mostly of fine-grained units of silt and clay. The Bootlegger



LOCATION MAP
SITE NS-1

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.19.1

Cove Formation in this area acts as an aquitard to groundwater moving toward Knik Arm.

The terrain in the vicinity of the ditch slopes to the west at about 40 feet per mile and has been modified by several past construction projects. A border of dense alders to a height of about 15 feet borders most of the ditch. No subsurface exploration was conducted at the site.

4.2.19.1.2 Site Hydrogeology

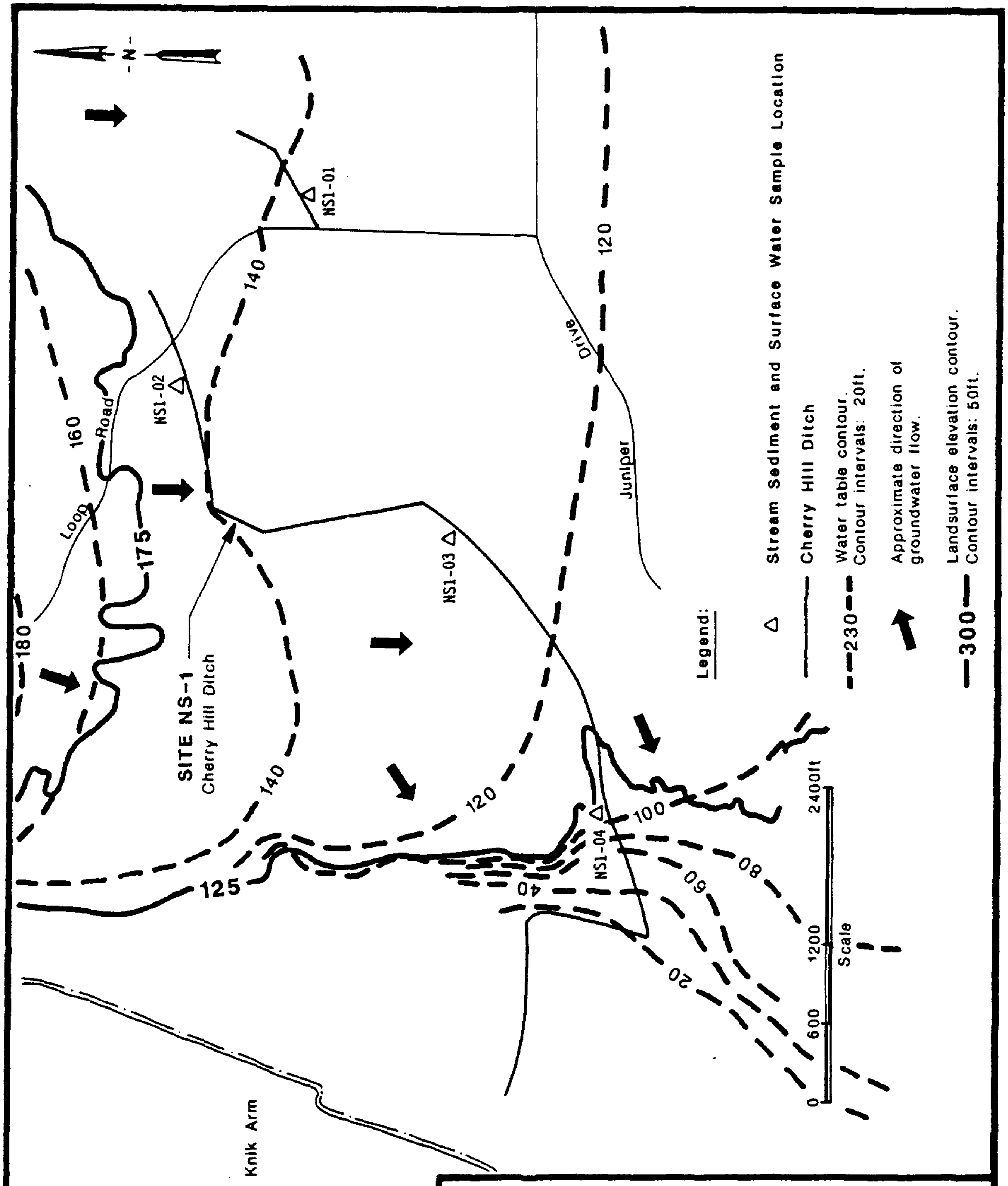
Site NS-1, the Cherry Hill Ditch, occurs in an area where the Bootlegger Cove Formation is within a few feet of the land surface. The Bootlegger Cove Formation is composed mostly of silts and clays with some sand and gravel units. The water table in this area is generally to a depth of 20 feet and, in developed areas, has probably been extensively modified by land drainage systems. The Cherry Hill Ditch is the primary drainage in the area and appears to receive considerable flow from the shallow groundwater system (Figure 4.2.19.2).

4.2.19.1.3 Analytical Results

Field analytical results and observations, and laboratory analytical results are discussed in the following sections.

4.2.19.1.3.1 Field Analytical Results and Observations

Water and sediment were sampled at 4 points along Cherry Hill Ditch. Sample location NS1-01 is located at the eastern end of the channel, south of the runway. The water at this location was stagnant. Surface scum and a hydrogen sulfide odor observed at this location were probably produced by decaying organic matter. The ditch at sample location NS1-01 is about 10 feet wide. The banks are steep and



HYDROGEOLOGIC MAP
SITE NS-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.19.2

bordered with willow, alder, and weeds. No petroleum odors or sheen were detected in the water or in the collected samples.

Sample location NS1-02 is located to the west of Loop Road. The ditch water at this location was flowing at a rate of about 0.5 cubic feet per second. The water was clear with no petroleum sheen or odor. However, agitation of the sample produced a slight but persistent foam. The channel is about 4 feet wide at this point and is bordered with moss and weeds.

Sample location NS1-03 is located downstream of a culvert beneath Acacia Drive, west of the base theater. The channel contained murky water with a slight sheen and petroleum odor. The flow rate was about 1 cubic foot per second in the 2-foot wide channel. Grasses and weeds lined the steeply sloping banks.

Sample location NS1-04 is located at a point where the ditch descends into a deep gulch. A 4-foot diameter culvert carries the water beneath Cherry Street into the gulch. Sampling was done at the downstream end of this culvert. Massive amounts of very thick (1 to 2 feet in places) stable foam were observed on 3 occasions at this site. Foam was also found in nearby trees on 1 occasion. There was a strong mothball odor and a slight sewer odor noted during sampling. Flow rate out of the culvert was about 3 cubic feet per second.

Field parameters measured at Site NS-1 during the surface water sampling are presented in Table 4.2.19.1.

4.2.19.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site NS-1 is presented on Table 4.2.19.2, and the sample plan for the base-wide field investigation plan is included in Appendix B. Major organic contaminants identified

Table 4.2.19.1 Field Parameters Site NS-1

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
NS1-01	8/06/88	11.0	510	6.02	358	Slight H2S odor only
NS1-02	8/06/88	10.0	400	7.44	214	Slight Foam and POL odor
NS1-03	8/06/88	11.5	215	7.56	102	Slight POL odor, sheen
NS1-04	8/06/88	12.0	260	7.17	116	Slight POL and sewage odors, massive foam

Table 4.2.19.2 Requested Laboratory Analyses for Samples from Site NS-1

<u>SEDIMENT</u>

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
6010	ICP Screen
7471	Mercury
8240	Volatile Organic Compounds
8270	Semi-volatile Organic Compounds
9010	Cyanide
160.3	Soil Moisture Content

<u>WATER</u>

Test Number	Analysis
300	Common Anions
418.1	Petroleum Hydrocarbons
200.7	ICP Screen (total and dissolved)
206.2	Arsenic (total and dissolved)
239.2	Lead (total and dissolved)
245.1	Mercury (total dissolved)
270.2	Selenium (total and dissolved)
601	Purgeable Halocarbons
SW602	Purgeable Aromatics
625	Extractable Priority Pollutants
335.3	Cyanide (total)

from the laboratory analyses of samples collected at Site NS-1 are plotted in Figures 4.2.19.3 through 4.2.19.12. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding sample location. Results of analytical tests for metals and other contaminants are presented on Table 4.2.19.3.

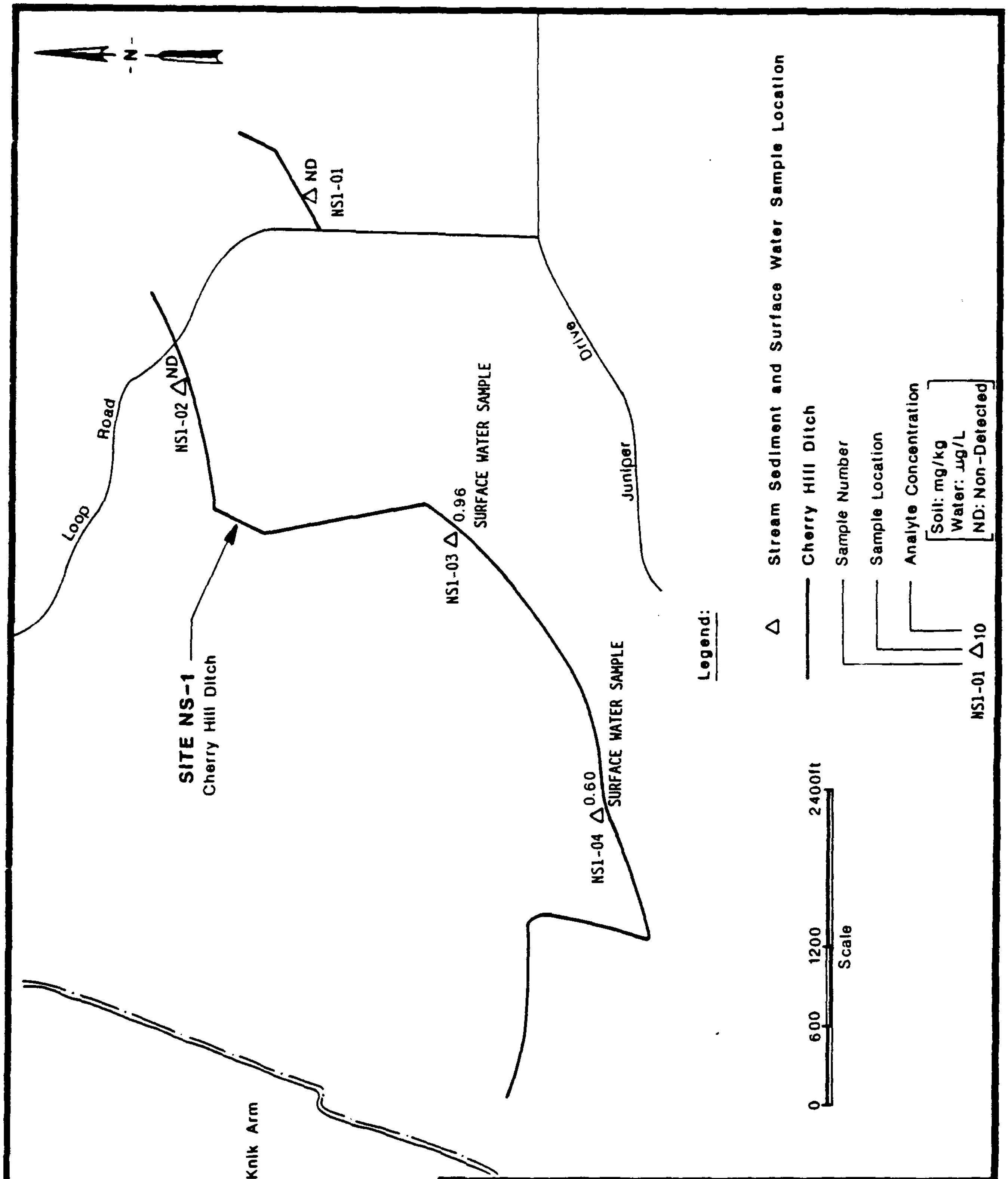
4.2.19.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at Site NS-1 are presented in Table 4.2.19.3.

4.2.19.1.5 Discussion of Analytical Data

Contamination by organic compounds was detected in several samples from 2 locations at Site NS-1 (Figures 4.2.19.3 through 4.2.18.12). Water samples from sample locations NS1-03 and NS1-04 contained chloroform at concentrations of 0.96 and 0.60 ug/L, respectively. The water sample from sample location NS1-04 also contained 1,1,1-trichloroethane (0.53 ug/L). A sediment sample from sample location NS1-03 contained a total petroleum hydrocarbon concentration of 436 mg/kg. This sediment sample also contained the following polycyclic aromatic hydrocarbons: benzo(a)anthracene (15 mg/kg), benzo(a)pyrene (16 mg/kg), benzo(b) fluoranthene (13 mg/kg), chrysene (21 mg/kg), fluoranthene (38 mg/kg), phenanthrene (30 mg/kg), and pyrene (27 mg/kg).

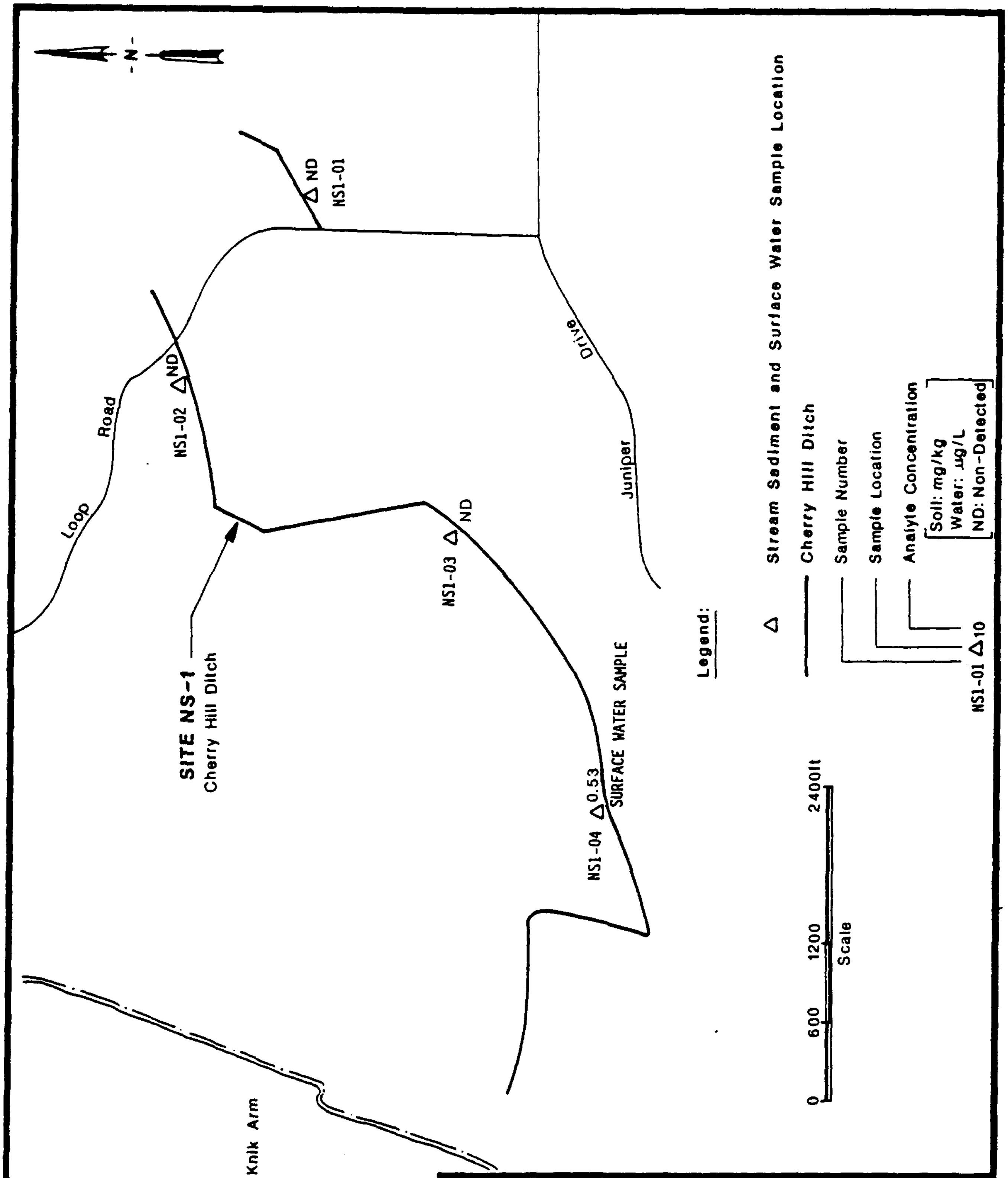
Metals such as aluminum (2300 to 16,000 mg/kg), iron (21,700 to 49,100 mg/kg), manganese (570 to 13,200 mg/kg) and magnesium (2300 to 9600 mg/kg) were detected in sediment samples from the site. Water samples also contained total metals at concentrations as high as 0.28 mg/L of aluminum, 12 mg/L of iron, 28 mg/L of manganese, and 28 mg/L of magnesium. No dissolved aluminum was detected; maximum concentrations



CHLOROFORM
CONCENTRATION
SITE NS-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

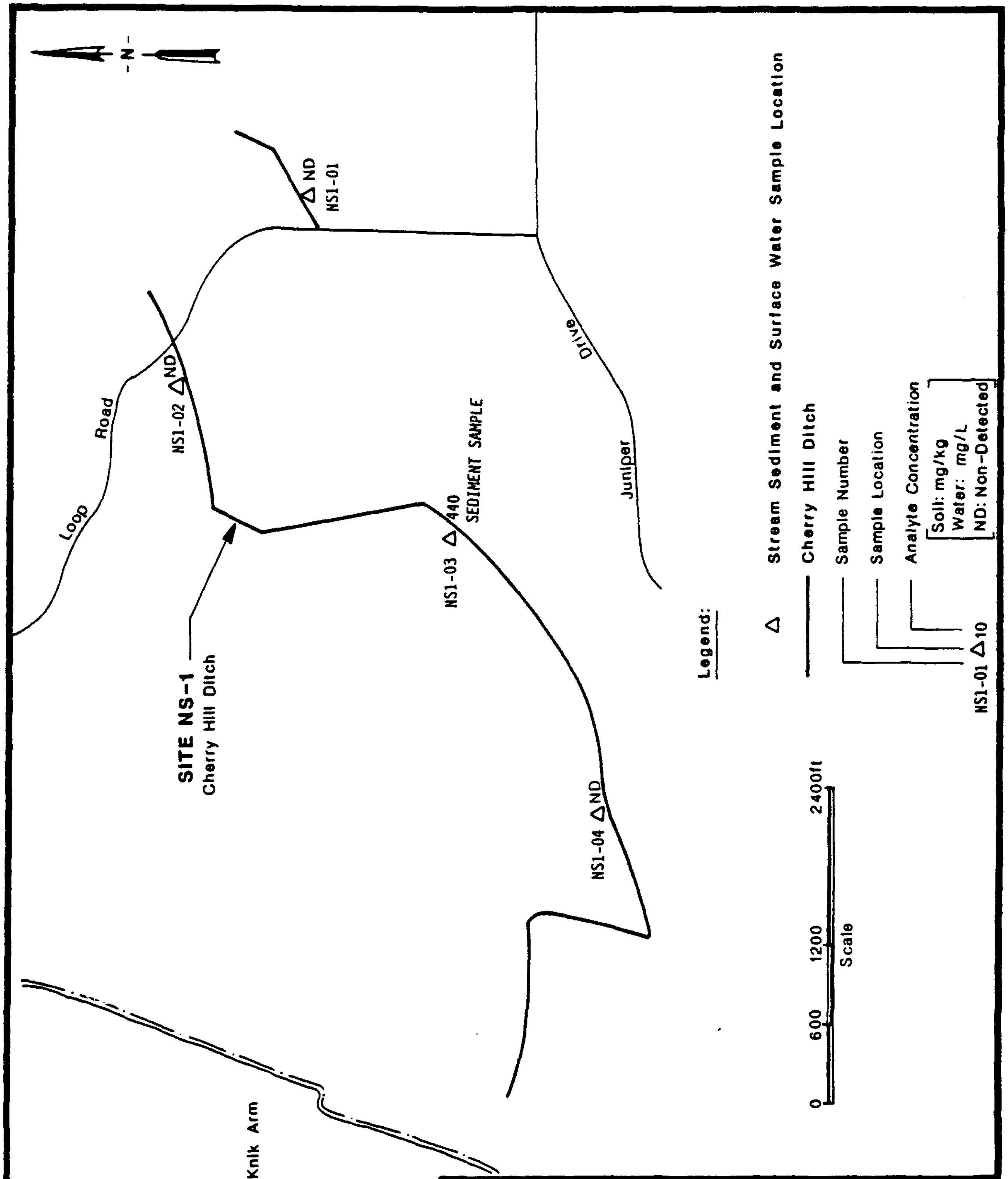
Figure
4.2.19.3



1,1,1-TRICHLOROETHANE CONCENTRATION SITE NS-1

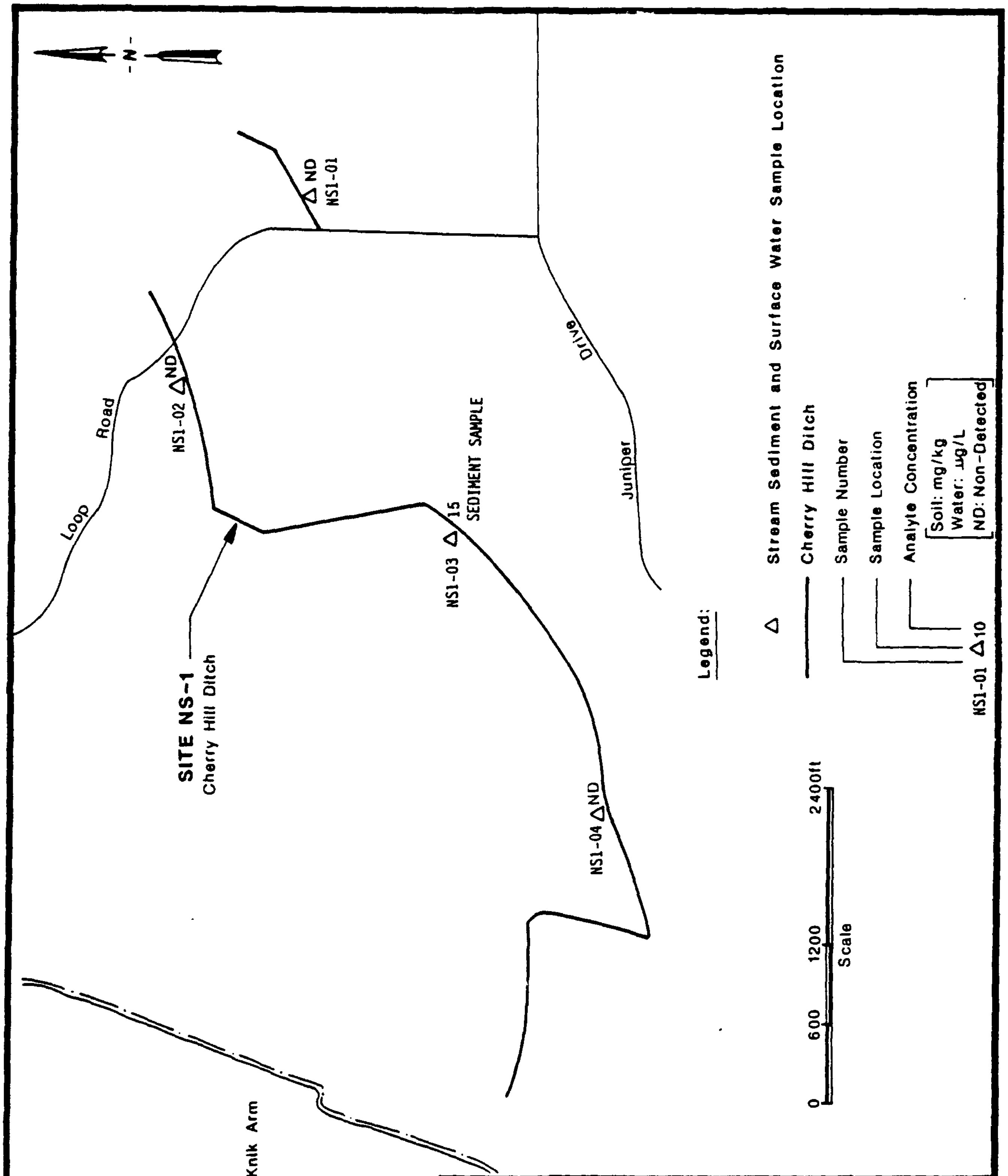
IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.19.4



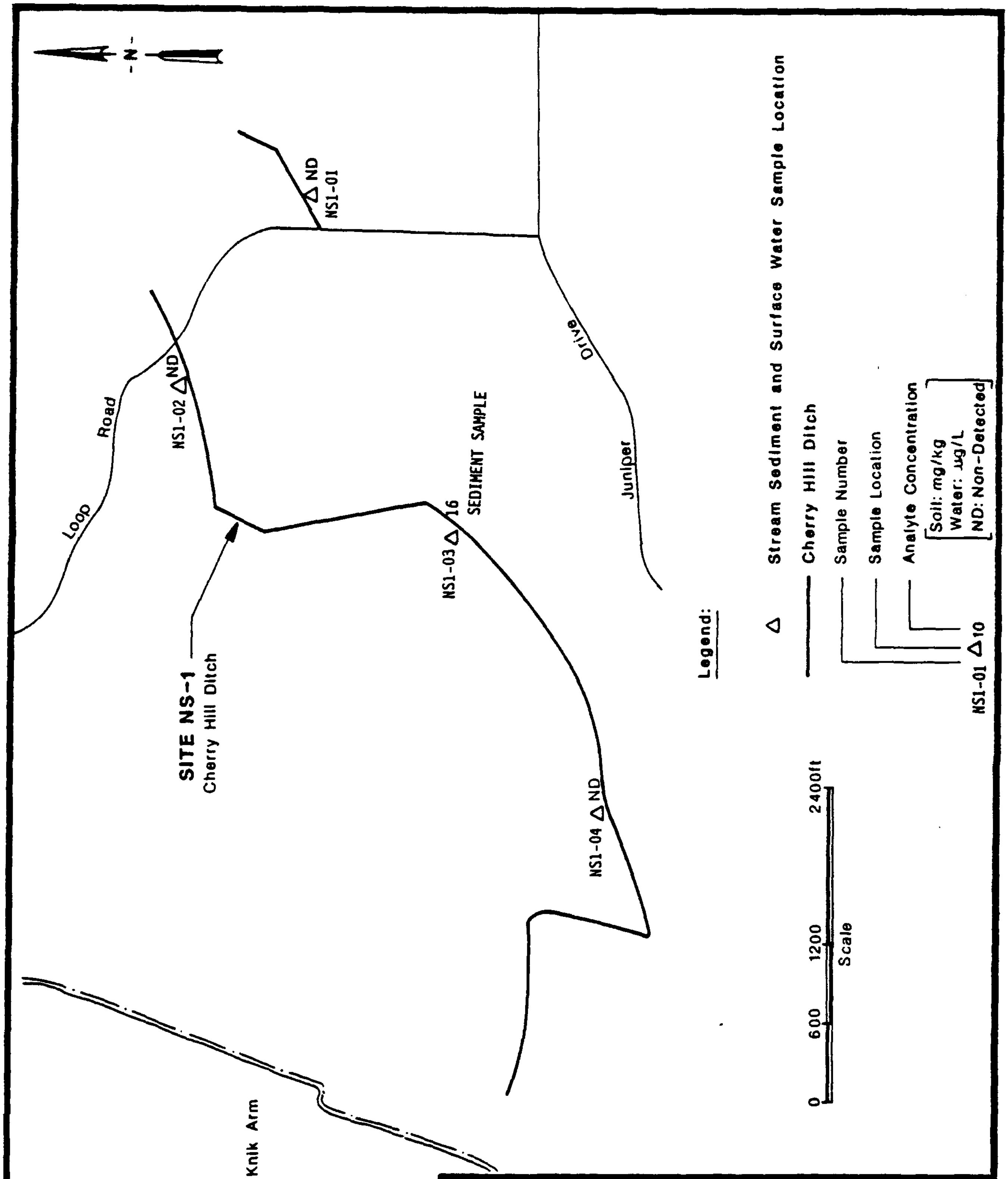
TOTAL PETROLEUM HYDROCARBON
CONCENTRATION
SITE NS-1

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.19.5



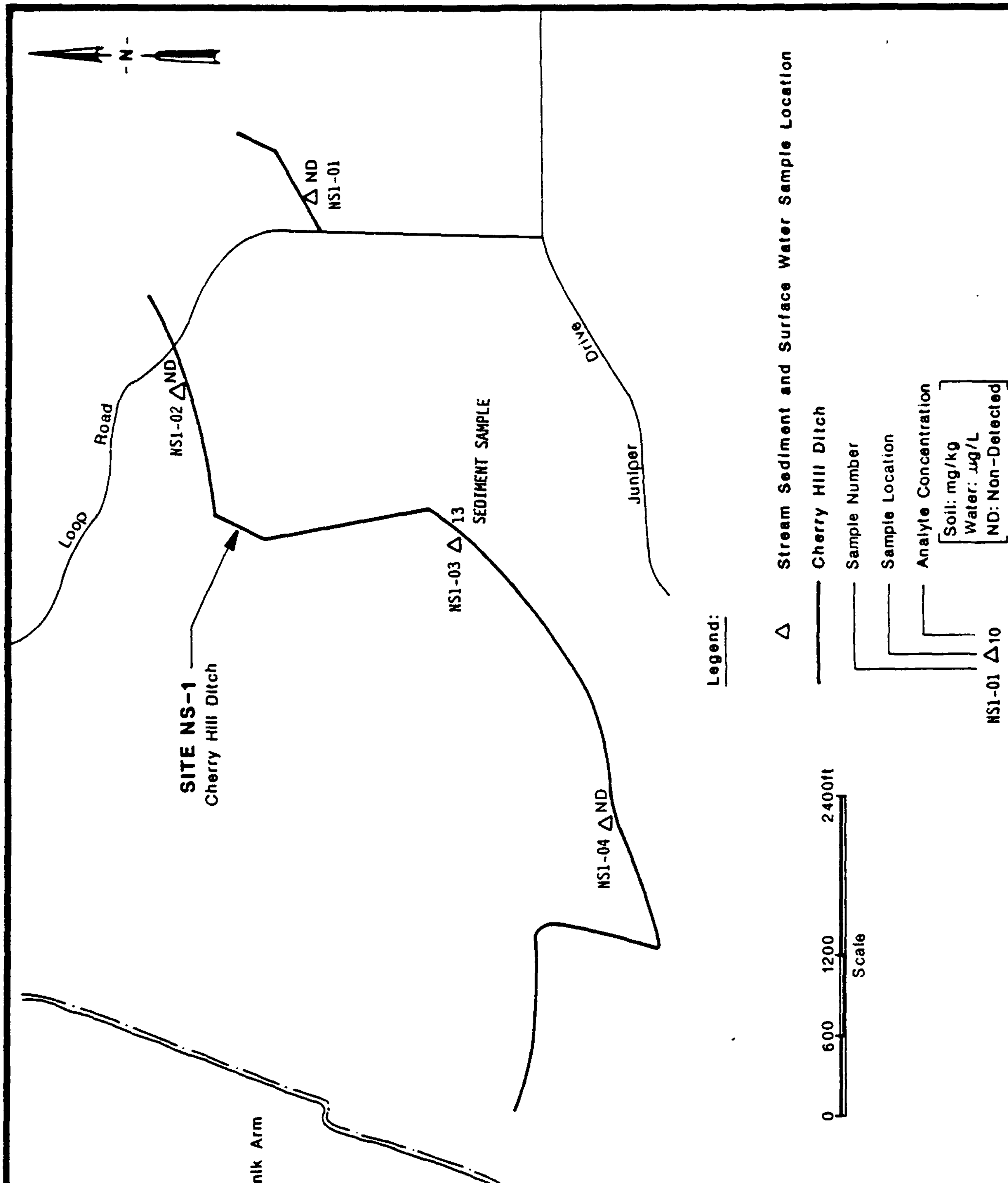
BENZO(a)ANTHRACENE
CONCENTRATION
SITE NS-1

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.19.6



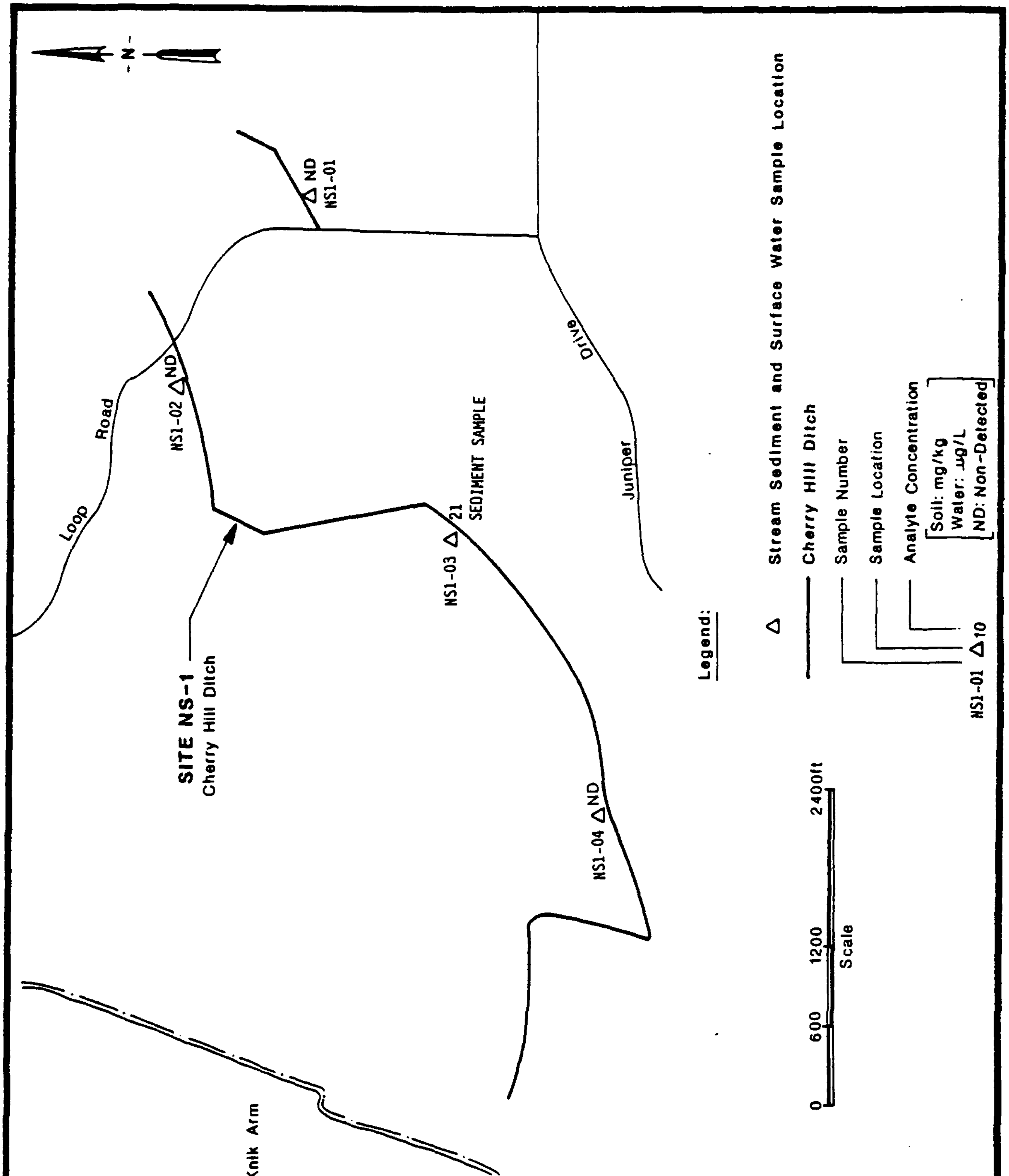
BENZO(a)PYRENE
CONCENTRATION
SITE NS-1

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.19.7



BENZO(b)FLUORANTHENE
CONCENTRATION
SITE NS-1

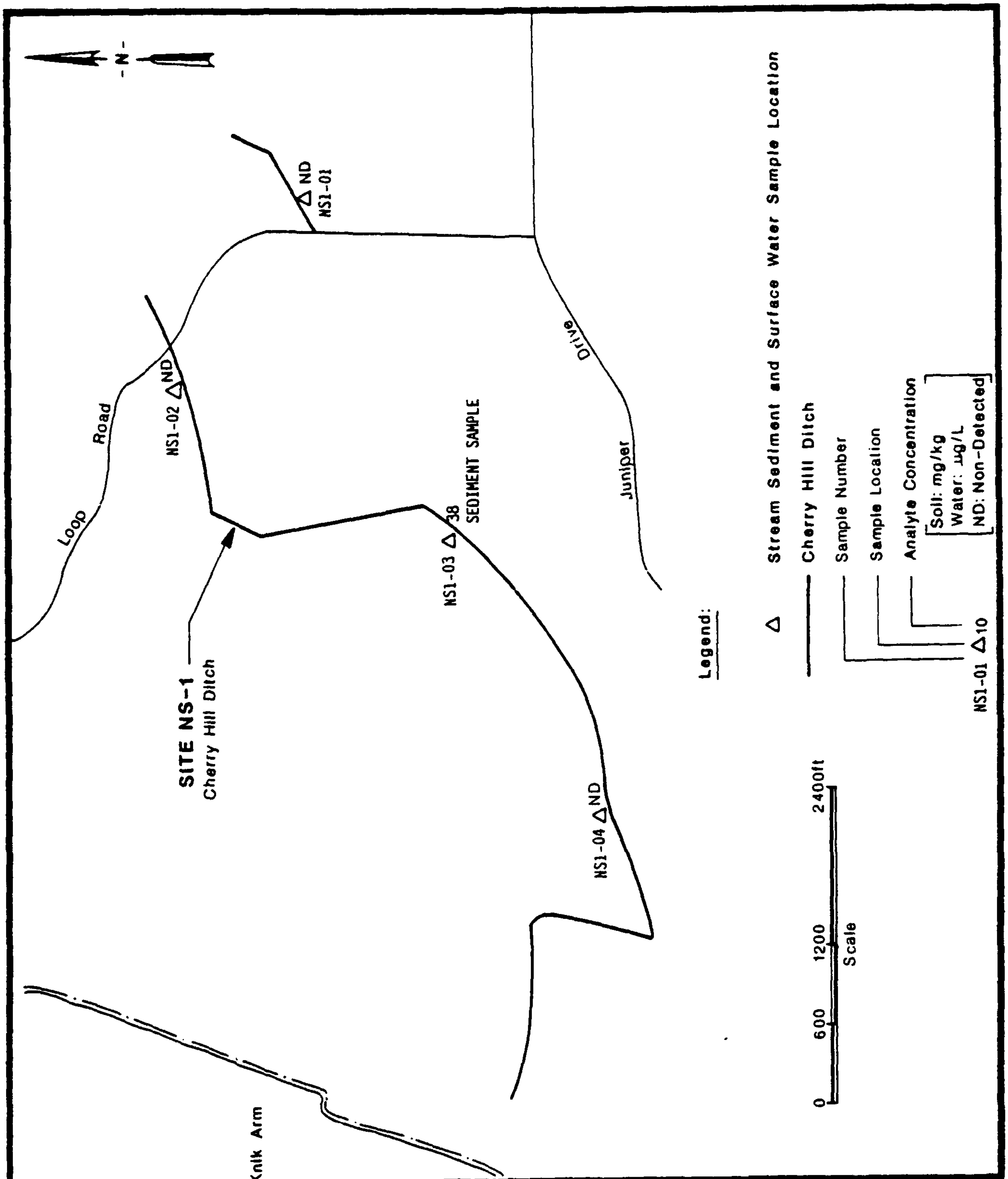
IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.19.8



CHRYSENE
CONCENTRATION
SITE NS-1

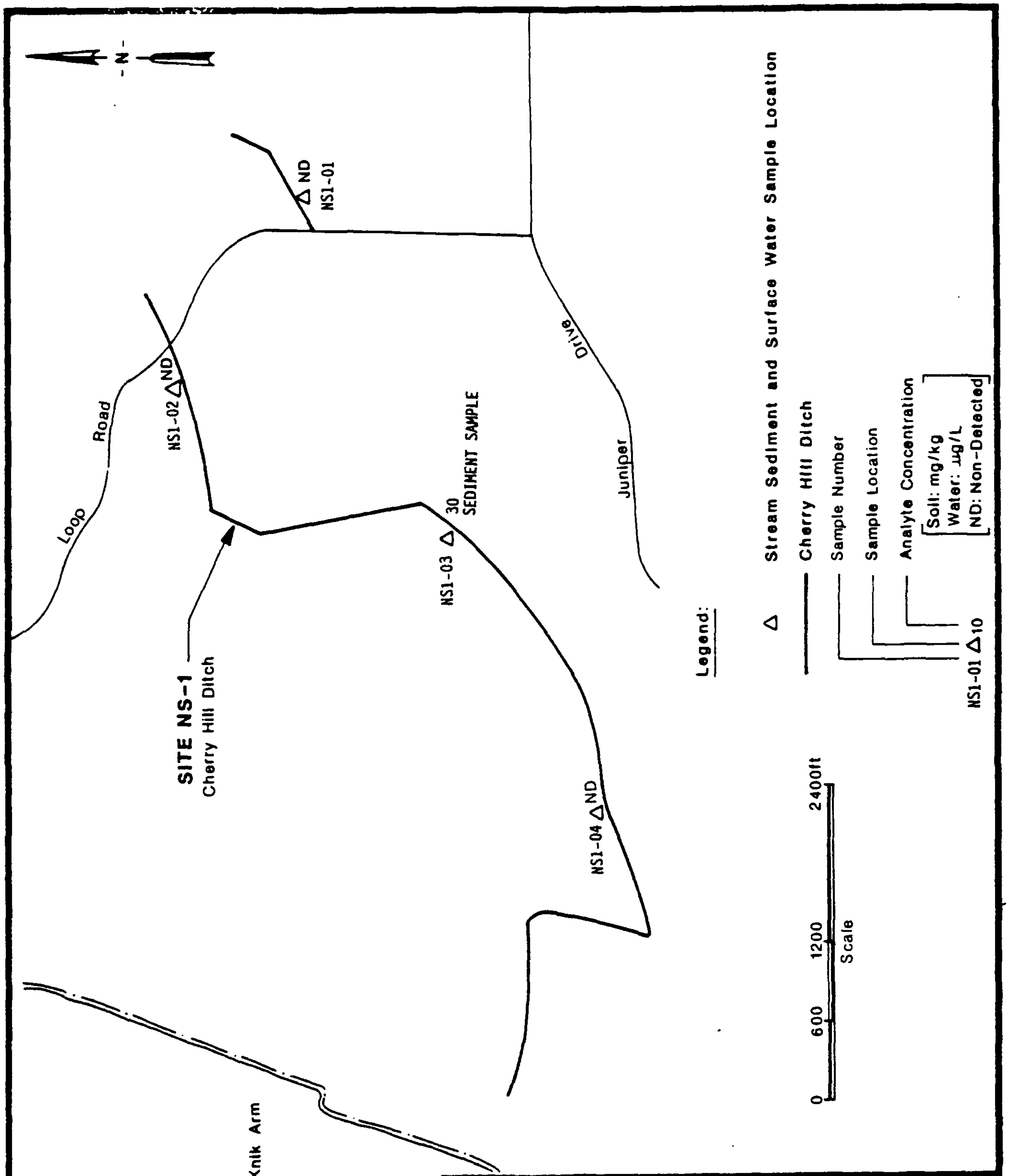
IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.19.9



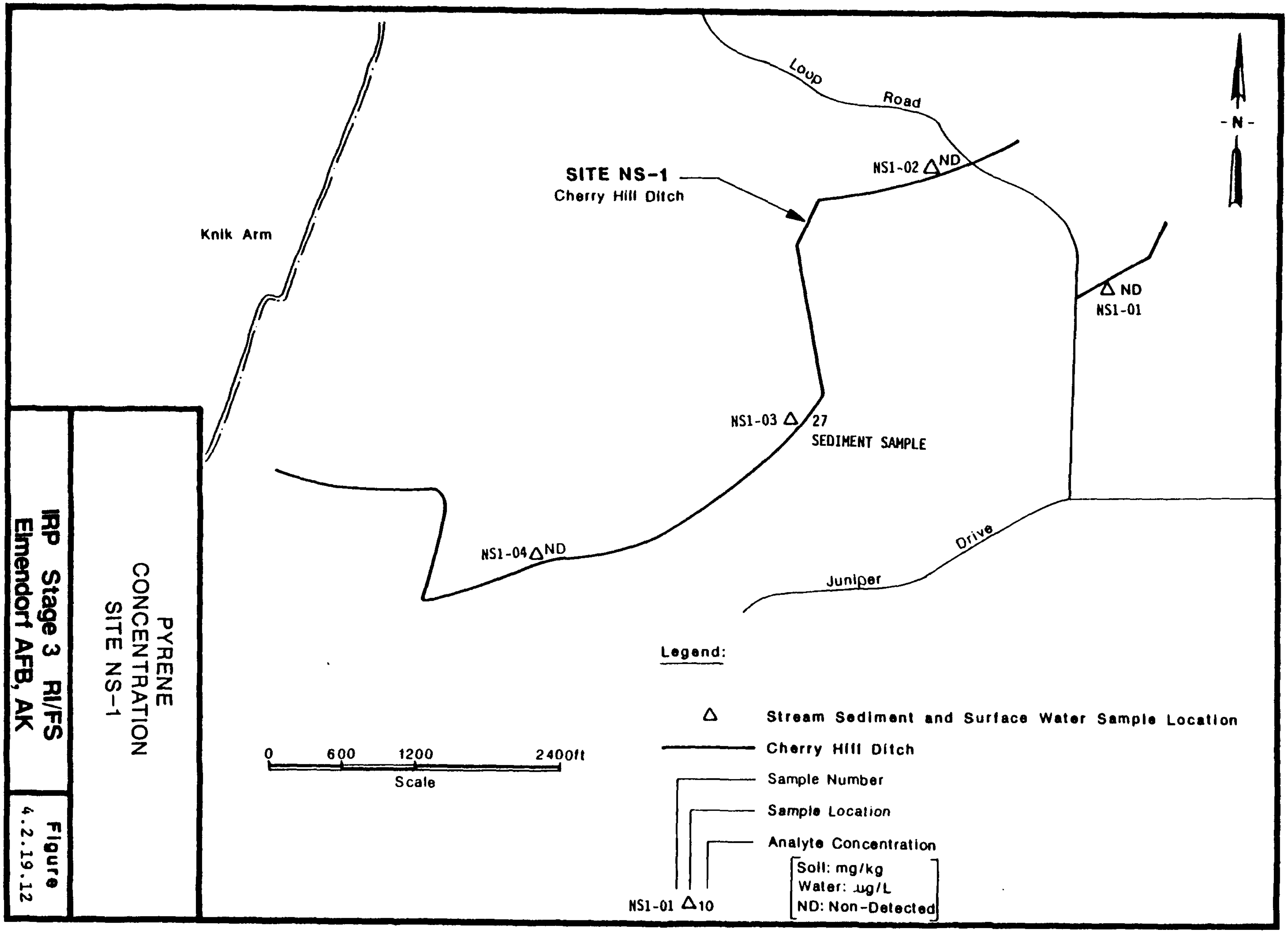
FLUORANTHENE
CONCENTRATION
SITE NS-1

IRP Stage 3 RI/FS **Elmendorf AFB, AK**	**Figure** 4.2.19.10



PHENANTHRENE
CONCENTRATION
SITE NS-1

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.19.11



PYRENE
CONCENTRATION
SITE NS-1

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.19.12

Table 4.2.19.3

Analytical Results - Site NS-1

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	NS1-01 0687-NS-102 GW-88-0002 001126-0001	NS1-01 RESAMPLE 0687-NS-102 GW-88-0002R 001324-0010	NS1-01 0687-SO-102 GS-88-0001 001130-0001	NS1-02 0687-NS-103 GW-88-0002 001126-0002	NS1-02 RESAMPLE 0687-NS-103 GW-88-0002R 001324-0011	NS1-02 0687-SO-103 GS-88-0001 001130-0002
1,1,1-Trichloroethane	EPA 601	ug/L	200						
Acetone	Method 8240	mg/kg	5,000						
Aluminum	6010	mg/kg				2300			15962
Arsenic	6010	mg/kg	0.42						70
Barium	6010	mg/kg				65			329
Benzo(a)anthracene	Method 8270	mg/kg							
Benzo(a)pyrene	Method 8270	mg/kg	0.061						
Benzo(b)fluoranthene	Method 8270	mg/kg							
Beryllium	6010	mg/kg							
Cadmium	6010	mg/kg							
Calcium	6010	mg/kg				14000			23709
Chloride	300.0	mg/L	250	7.4			7.4		
Chloroform	EPA 601	ug/L	100						
Chromium	6010	mg/kg	50,000						19
Chrysene	Method 8270	mg/kg							
Cobalt	6010	mg/kg							19
Copper	6010	mg/kg	1,850			40			28
Cyanide, Total	335.3	mg/L		0.02			0.02		
Dissolved Arsenic	206.2	mg/L	0.05	0.011	0.014				
Dissolved Barium	200.7	mg/L	1.0		0.11			0.11	
Dissolved Calcium	200.7	mg/L			86.			53.	
Dissolved Copper	200.7	mg/L	1.0						
Dissolved Iron	200.7	mg/L	0.3		9.3			0.11	
Dissolved Lead	239.2	mg/L	0.05						
Dissolved Magnesium	200.7	mg/L			26.			15.	
Dissolved Manganese	200.7	mg/L	0.05		12.			0.32	
Dissolved Sodium	200.7	mg/L	250		14.			12.	
Dissolved Zinc	200.7	mg/L	5.0		0.04			0.01	
Fluoranthene	Method 8270	mg/kg							
Iron	6010	mg/kg				29500			49061
Lead	6010	mg/kg	70						
Magnesium	6010	mg/kg				2350			9624
Manganese	6010	mg/kg	11,000			3100			13146
Mercury	7471	mg/kg	100			1.35			0.35
Nickel	6010	mg/kg				75			47
Nitrate as N	300.0	mg/L	10				3.9		
Phenanthrene	Method 8270	mg/kg							
Pyrene	Method 8270	mg/kg							
Recoverable Aluminum	200.7	mg/L		0.11					
Recoverable Arsenic	206.2	mg/L	0.05	0.017					
Recoverable Barium	200.7	mg/L	1.0	0.065			0.042		
Recoverable Calcium	200.7	mg/L		94.			75.		
Recoverable Copper	200.7	mg/L	1.0	0.007					
Recoverable Iron	200.7	mg/L	0.3	12.			0.32		
Recoverable Lead	239.2	mg/L	0.05	0.010			0.003		
Recoverable Magnesium	200.7	mg/L		28.			22.		
Recoverable Manganese	200.7	mg/L	0.05	13.			0.44		
Recoverable Sodium	200.7	mg/L	250	11.			8.1		
Sodium	6010	mg/kg							258
Sulfate	300.0	mg/L	250	28.			31.		
Total Mercury	245.1	mg/L	0.002		0.0002				
Total Petroleum Hydrocarbons	3550/418.1 Mod.								
Total Solids	160.3	%				20.0			42.6
Vanadium	6010	mg/kg	1,000			20			63
Zinc	6010	mg/kg	10,500			65			423

Table 4.2.19.3

Analytical Results - Site NS-1

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	NS1-03 0687-NS-104 GW-88-0002 001126-0003	NS1-03 RESAMPLE 0687-NS-104 GW-88-0002R 001324-0012	NS1-03 0687-SO-104 GS-88-0001 001130-0003	NS1-04 0687-NS-105 GW-88-0002 001126-0004	NS1-04 RESAMPLE 0687-NS-105 GW-88-0002R 001324-0013	NS1-04 0687-SO-105 GS-88-0001 001130-0005
1,1,1-Trichloroethane	EPA 601	ug/L	200				0.53		
Acetone	Method 8240	mg/kg	5,000						
Aluminum	6010	mg/kg				14773			10771
Arsenic	6010	mg/kg	0.42						
Barium	6010	mg/kg				186			86
Benzo(a)anthracene	Method 8270	mg/kg				15			
Benzo(a)pyrene	Method 8270	mg/kg	0.061			16.3			
Benzo(b)fluoranthene	Method 8270	mg/kg				13			
Beryllium	6010	mg/kg				0.4			0.2
Cadmium	6010	mg/kg				8			
Calcium	6010	mg/kg				6818			12018
Chloride	300.0	mg/L	250	4.6			5.9		
Chloroform	EPA 601	ug/L	100	0.96			0.60		
Chromium	6010	mg/kg	50,000			117			25
Chrysene	Method 8270	mg/kg				21			
Cobalt	6010	mg/kg				11			9
Copper	6010	mg/kg	1,850			190			31
Cyanide, Total	335.3	mg/L		0.01					
Dissolved Arsenic	206.2	mg/L	0.05		0.003			0.003	
Dissolved Barium	200.7	mg/L	1.0		0.025			0.12	
Dissolved Calcium	200.7	mg/L			29.			28.	
Dissolved Copper	200.7	mg/L	1.0		0.010			0.010	
Dissolved Iron	200.7	mg/L	0.3		0.13			0.13	
Dissolved Lead	239.2	mg/L	0.05	0.004			0.002		
Dissolved Magnesium	200.7	mg/L			7.7			7.1	
Dissolved Manganese	200.7	mg/L	0.05		0.30			0.23	
Dissolved Sodium	200.7	mg/L	250		8.2			12.	
Dissolved Zinc	200.7	mg/L	5.0		0.03			0.01	
Fluoranthene	Method 8270	mg/kg				38			
Iron	6010	mg/kg				30303			21655
Lead	6010	mg/kg	70			852			57
Magnesium	6010	mg/kg				8333			7370
Manganese	6010	mg/kg	11,000			568			850
Mercury	7471	mg/kg	100			0.45			
Nickel	6010	mg/kg				40			27
Nitrate as N	300.0	mg/L	10	1.4			1.3		
Phenanthrene	Method 8270	mg/kg				30			
Pyrene	Method 8270	mg/kg				27			
Recoverable Aluminum	200.7	mg/L		0.28			0.13		
Recoverable Arsenic	206.2	mg/L	0.05						
Recoverable Barium	200.7	mg/L	1.0	0.033			0.028		
Recoverable Calcium	200.7	mg/L		32.			30.		
Recoverable Copper	200.7	mg/L	1.0	0.006					
Recoverable Iron	200.7	mg/L	0.3	0.88			0.61		
Recoverable Lead	239.2	mg/L	0.05	0.008			0.005		
Recoverable Magnesium	200.7	mg/L		9.5			9.3		
Recoverable Manganese	200.7	mg/L	0.05	0.51			0.43		
Recoverable Sodium	200.7	mg/L	250	11.			10.		
Sodium	6010	mg/kg				265			125
Sulfate	300.0	mg/L	250	16.			19.		
Total Mercury	245.1	mg/L	0.002		0.0001				
Total Petroleum Hydrocarbons	3550/418.1 Mod.					436			
Total Solids	160.3	%				52.8			88.2
Vanadium	6010	mg/kg	1,000			57			43
Zinc	6010	mg/kg	10,500			455			98

of dissolved iron, manganese, and magnesium were 9.3, 12, and 26 mg/L respectively.

Calcium levels in sediment (6818 to 23,700 mg/kg) and water (total: 30 to 94 mg/L) and sodium levels in soil (120 to 260 mg/kg) and water (8.1 to 11 mg/L) is due to the natural mineral content of the surrounding soils. Sodium was detected in soil from all locations except sample location NS1-01.

Sulfate and chloride ions were detected in water samples from all locations at concentrations ranging from 16 to 31 mg/L and 4.6 to 7.4 mg/L, respectively.

Barium (65 to 330 mg/kg), copper (28 to 190 mg/kg), nickel (27 to 75 mg/kg), vanadium (20 to 63 mg/kg) and zinc (13 to 450 mg/kg) were detected in sediment samples from all locations. The highest lead (850 mg/kg), zinc (450 mg/kg), chromium (120 mg/kg), and copper (190 mg/kg) concentrations were detected in the sediment sample from sample location NS1-03. This sample also contained beryllium (0.38 mg/kg) and cadmium (7.6 mg/kg). Arsenic (70 mg/kg) was detected in the sediment sample from sample location NS1-02. The highest mercury concentration (1.4 mg/kg) was detected in sediment from sample location NS1-02.

All water samples from the site contained dissolved barium (0.033 to 0.11 mg/L). Dissolved arsenic (0.003 to 0.014 mg/L) and was detected in water samples from sample locations NS1-01, NS1-03 and NS1-04. Dissolved copper (0.01 mg/L) was detected in water samples from sample locations NS1-03 and NS1-04. Water samples from sample locations NS1-01 and NS1-03 contained mercury at concentrations of 0.0002 and 0.0001 mg/L, respectively.

4.2.19.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site NS-1 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.19.2.1 Loss of Samples

No soil or water samples collected for laboratory analyses were lost from Site NS-1.

4.2.19.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely, that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in soil or water samples from Site NS-1.

4.2.19.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Four locations along Cherry Hill Ditch were sampled for surface water and stream sediments. The water samples to be tested for dissolved metals were not originally filtered in the field. This action was corrected by resampling the 4 locations for dissolved metals only, and filtering the samples onsite prior to shipment.

4.2.19.2.4 Corrective Actions Applied to Out-of-Control Events, Including a Chronology of Rerunning Samples and Controls

Water samples were retaken from all 4 locations at Site NS-1 and tested for dissolved metals. The following table shows when sampling and resampling activities were conducted.

Sample Location Number	Original Sampling Date	Resampling Date
NS1-01	8/6/88	8/20/88
NS1-02	8/6/88	8/20/88
NS1-03	8/6/88	8/20/88
NS1-04	8/6/88	8/20/88

4.2.19.3 Significance of Findings

Analytical methods detected organic compounds, petroleum hydrocarbons and metals in sediment and water samples from Site NS-1. Chloroform and 1,1,1-trichloroethane were detected in water samples from the site, but at levels below the EPA Maximum Contaminant Levels (MCLs). Water samples from sample locations NS1-02, NS1-03 and NS1-04 at Site NS-1 exhibited a petroleum odor, sheen, and/or foam, thereby exceeding State of Alaska drinking water standards.

A sediment sample from the site contained petroleum hydrocarbons and polycyclic aromatic hydrocarbons. There are no existing or proposed sediment cleanup levels for petroleum hydrocarbons. Benzo(a) pyrene was above the calculated soil cleanup level of 0.061 mg/kg as discussed in Section 4.1.

Large amounts of a stable foam (up to 2 feet thick) were observed at sample location NS1-04 on 3 occasions. The foam probably forms during

agitation of the water as it flows out of a culvert immediately upstream of the sample point. The composition of the foam is unknown and the foam is not aesthetically appealing.

The source of petroleum hydrocarbons, organics, and metals in the sediment and water at this site is runoff from the runway and/or building drains from hangars surrounding the runway. Another source of petroleum hydrocarbons at sample location NS1-03 is the nearby parking lots. Contaminated surface water runoff from the lots could easily enter the ditch. The specific quantities and types of contaminants spilled or leaked has never been determined. However, the contaminants are expected to be jet and diesel fuels, solvents, and deicing fluids.

The levels of metals detected in water samples from this site, although some are above secondary levels, are not higher than expected background levels, with the possible exception of iron and manganese. These metals were detected at much higher dissolved concentrations than at the basewide hydrogeology (background) wells.

Pathways of exposure are contact with an ingestion or uptake of contaminated surface water or contact with the foam or contaminated sediment. Receptors of the contamination are humans, wildlife, fish and plants.

4.2.19.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. No organic contamination was detected in analytical samples from upstream sample locations NS1-01 and NS1-02. However, a slight petroleum odor and sheen was observed during sampling at sample location NS1-02. Chloroform was detected in water at sample location NS1-03. Sediments from this location were also

contaminated with numerous PAH compounds and petroleum hydrocarbons. This is the only location at the site where sediment samples were contaminated with organic compounds. Water from the fourth and most downstream location contained chloroform and 1,1,1-trichloroethane. Large amounts of foam were observed at this location.

4.2.19.3.2 Contaminant Migration

The primary migration medium is the surface waters of the Cherry Hill Ditch. Any contaminants dissolved in the ditch water would flow along its course to the outfall at Cook Inlet.

4.2.19.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off-Base migration is unknown. Cherry Hill ditch flows across installation boundaries and discharges to Cook Inlet. Migration can occur by these 2 receptors if contaminants were to reach them.

4.2.19.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site identified the stream gradient to be about 40 to 50 feet per mile. The stream flows toward the southwest. Flow rate of the ditch ranges from stagnant water to water flowing at a velocity of 2 cubic feet per second.

4.2.19.3.2.3 Time of Travel to Receptors

Time of travel to receptors is negligible since surface waters are contaminated. Primary receptors are humans, plants, fish, and wildlife. The primary pathway is through surface waters of the Cherry Hill Ditch. Other pathways are through contact with foam or contaminated sediments. There are no active drinking water wells downgradient of Cherry Hill Ditch.

4.2.19.3.2.4 Applicability of Solute Transport Models

Solute transport models may be important at Site NS-1. The results of this modeling would help to determine the potential risk for down-gradient water supplies and surface water.

4.2.19.3.2.5 Expected Spatial and Temporal Variations in Concentration (NS-1)

Cherry Hill Ditch flows toward the southwest. Any contamination introduced to the ditch is expected to flow along with ditch water. At times of high flow rate the contamination may become highly diluted.

Temporal variations may exist due to seasonal changes in surface water conditions. Ditch flow rates and volumes, affecting dilution of contaminants, may be greatly changed by freezing and/or inflow of additional precipitation. Solubility of metals is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.19.3.3 Baseline Risk Assessment

The contamination in relation to exposure routes, receptors, and health effects are evaluated in the following sections.

4.2.19.3.3.1 Waste Characterization

The primary organic wastes at the site are petroleum hydrocarbons, chloroform, and 1,1,1-trichloroethane. Polycyclic aromatic hydrocarbons and petroleum hydrocarbons were detected in sediment

samples at sample location NS1-03. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects. PAH compounds detected at sample location NS1-03 include: phenanthrene, chrysene, fluoranthene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, and pyrene. PAHs are commonly found in coal tars fuels, and motor oils and all have tumorigenic neoplastic effects.

Chloroform and 1,1,1-trichloroethane were detected in water samples, these compounds are suspected human carcinogens. However, concentrations detected in Cherry Hill Ditch water were nearly 3 orders-of-magnitude lower than drinking water standards for both compounds.

The composition of the foam observed at sample location NS1-04 is not known, but is likely related to contamination of water near that point.

4.2.19.3.3.2 Source and Release Characterization

Volatile organic compounds and petroleum hydrocarbons may have been released to the environment through runway drains, building drains, and parking lot runoff. The specific amount or type of contaminants were never recorded. However, the runoff is expected to contain JP-4, diesel and MOGAS fuel. The PAH detected may have originated from fuels, oils, or asphalt on the base. In addition, deicing fluids and solvents from building drains are expected.

4.2.19.3.3.3 Fate and Transport of Contaminants

The fate of volatile organics and petroleum hydrocarbons released to the environment at Site NS-1 includes long-term natural degradation, dispersion of the contaminants through runoff, or uptake by living organisms. Volatilization is another possible fate for chloroform and

1,1,1-trichloroethane since their vapor pressures are greater than 1 mm of Hg (100 mm at 10.4 C and 100 mm at 20 C, respectively).

Dissolved contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration with the groundwater through the process of advection. Additional transport may be from the release of vapor to the atmosphere. Contaminated water or soil from the site can be transported through human intervention.

4.2.19.3.3.4 Exposure Pathways

The exposure pathway for humans, fish, and wildlife is contact with or ingestion of contaminated surface water, fish or plants. A second pathway is through contact with contaminated sediments and foam.

4.2.19.3.3.5 Identification of Receptors

Receptors are humans, fish, wildlife and plants. Human receptors include anyone coming in contact with ditch water or the stable foam observed at sample location NS1-04. In addition, humans may be exposed to contamination by the ingestion of plants or berries that have taken up ditch water. Fish were not observed to inhabit the ditch.

4.2.19.3.3.6 Threat to Human Health

A possible threat to human health is the drinking of or contact with water from Cherry Hill Ditch. However, this threat is assessed as low since it is unlikely that anyone would drink the water due to the presence of petroleum odor and foam at the most contaminated sites. Contaminant concentrations are within drinking water limits and dermal contact with creek water does not constitute a threat. The overall threat to human health is assessed as low for Site NS-1.

4.2.19.3.3.7 Carcinogenic Risks

Chloroform, an EPA category B2 (suspected) carcinogen, was detected in 2 water samples from NS-1 at concentrations of 0.96 and 0.6 ug/L. The EPA MCL for total trihalomethanes is 100 ug/L. Various PAHs, also suspected carcinogens, were detected in the sediment at sample location NS1-03.

4.2.19.3.3.8 Threat to Wildlife

Threat to wildlife is possible through ingestion of contaminated surface waters. Large amounts of stable foam observed at sample location NS1-04 also constitute a threat through ingestion. The chemical composition of the foam and its effects are not known. Overall threat to wildlife is moderate.

4.2.19.4 Prioritization of Sites for Remedial Alternatives

Due to the detection of petroleum hydrocarbons, halogenated hydrocarbons, and PAHs, including suspected human carcinogens, in water and sediment samples from this site, additional sampling of the water and sediment at Site NS-1 is needed. In addition, the observation of large amounts of very stable foam at sample location NS1-04 is a cause of concern from a health and aesthetic viewpoint. As upgradient problems are solved (i.e., hangar drains, Site SP-7/10 etc.), samples from the ditch should reflect the cleanup efforts. The site is recommended for medium priority status. Sampling of the 4 existing locations is required. An additional sample point should be located upgradient of Loop Road near the end of the runway. Two other sample points should be added near existing sampling point NS1-03. NS1-03 is located just downgradient of where a 48" storm sewer enters the ditch. Review of the Base storm drainage system shows that this particular storm sewer drains a large portion of the residential and office area of the Base. One of the new sampling points should be in

the storm sewer manhole just before it enters the ditch. The other point should be in Cherry Hill Ditch just upgradient of where the storm sewer enters the ditch.

As before, both surface water and sediments should be sampled. (Sediments should be collected from the storm drain, if possible.) Sediments analyses should include volatile aromatic compounds, purgeable halocarbons, and petroleum hydrocarbons. Water samples should be analyzed for surfactants in addition to those tests listed for sediments. The stable foam observed at NS1-04 should also be samples and analyzed for the same constituents as the water samples. The foam can be sampled with a 100 ul capillary tube, which would be placed at an angle into the foam and shook. The ends of the tube would then be capped for shipment to the laboratory.

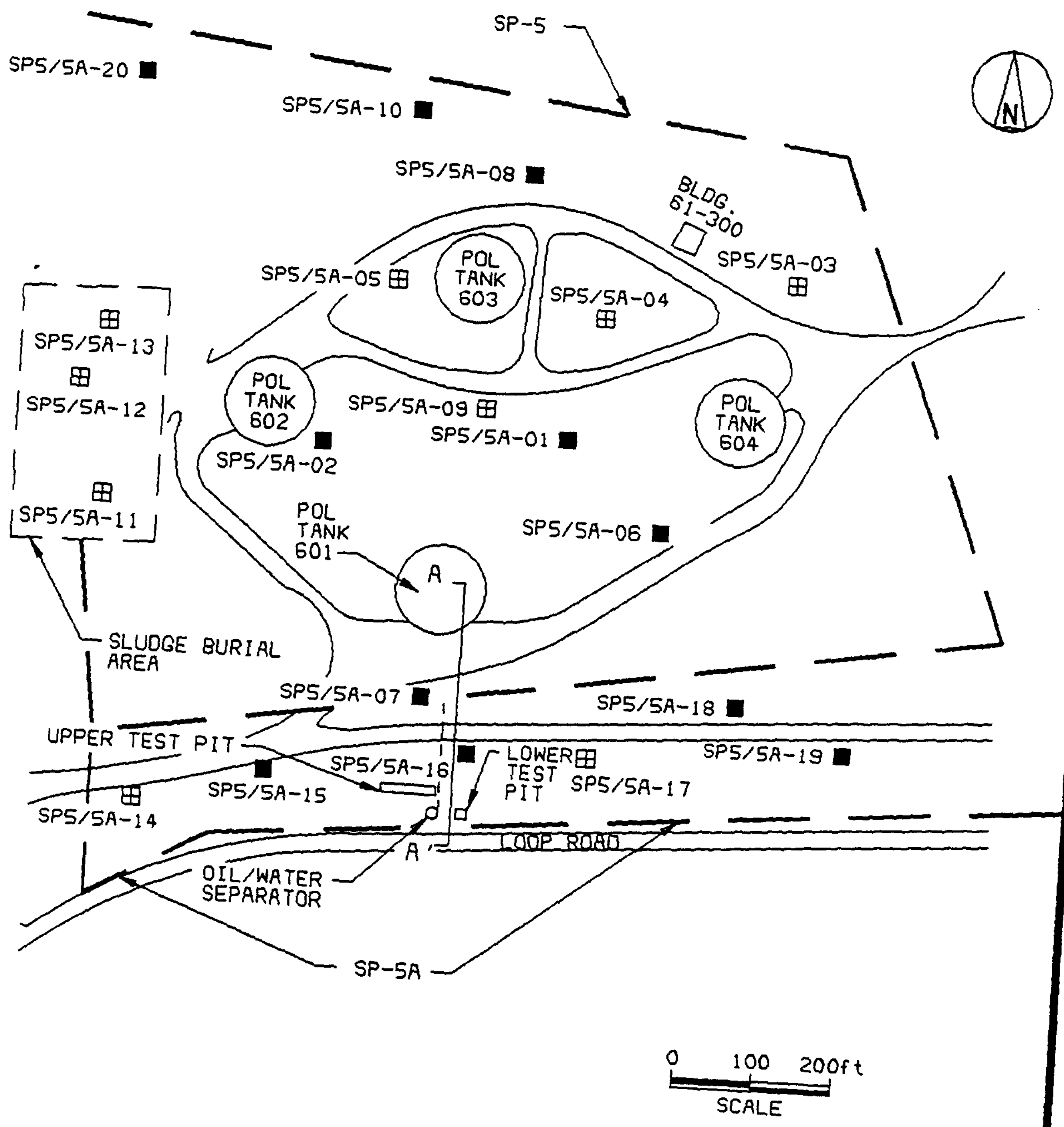
4.2.20 Discussion of Results for Site SP-5/5A, JP-4 Tank Spill

Site SP5/5A (Figure 4.2.20.1) is a POL storage site consisting of four 1,000,000 gallon bulk fuel storage tanks numbered 601 through 604. The site, also known as Four Million Gallon Hill has been the site of numerous spills (releases) since these aviation gasoline (AVGAS) storage tanks were installed in the early 1940's. They are interconnected and gravity fed with no check values between the tanks. A 60,000 gallon AVGAS spill occurred in the mid-1960's. On 30 August 1974, 33,000 gallons of the JP-4 fuel were spilled; approximately 16,000 gallons were recovered. Several million gallons of JP-4 fuel were also reportedly spilled in this area between 1973 and 1974 (Harding Lawson, 1988). Fuel from this tank system has been observed seeping from the hillside into an oil/water separator and into the ditch adjacent to the roadway northwest of the west end of the east-west runway (Dames and Moore, 1987). The oil/water separator is simply a 1000 gallon storage tank. When full the free product is recovered from the tank (Godsave, USAF, personal communication, 22 June, 1989).

4.2.20.1 Presentation of Results from Site SP-5/5A

Results of the hydrogeologic investigations are presented. In addition, analytical results are tabulated and presented on the site maps.

An additional field investigation program for Site SP-5/5A was completed during October and November 1989. A soil gas survey was attempted; however, due to the west conditions, it was abandoned. Six borings were drilled near the south of the site. All borings were completed as monitoring wells. The results of the additional field investigation program are included in Appendix R includes a discussion of the field investigation program, boring logs, well installation diagrams, chain-of-custody forms, and analytical data.



LEGEND

⊞ SPS/5A-01 TEST BORING

■ SPS/5A-03 BORING COMPLETED AS A MONITORING WELL

A——A' CROSS-SECTION

- - - - - - - BURIED DRAIN PIPE TO OIL/WATER SEPARATOR

SITE LOCATION MAP

SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

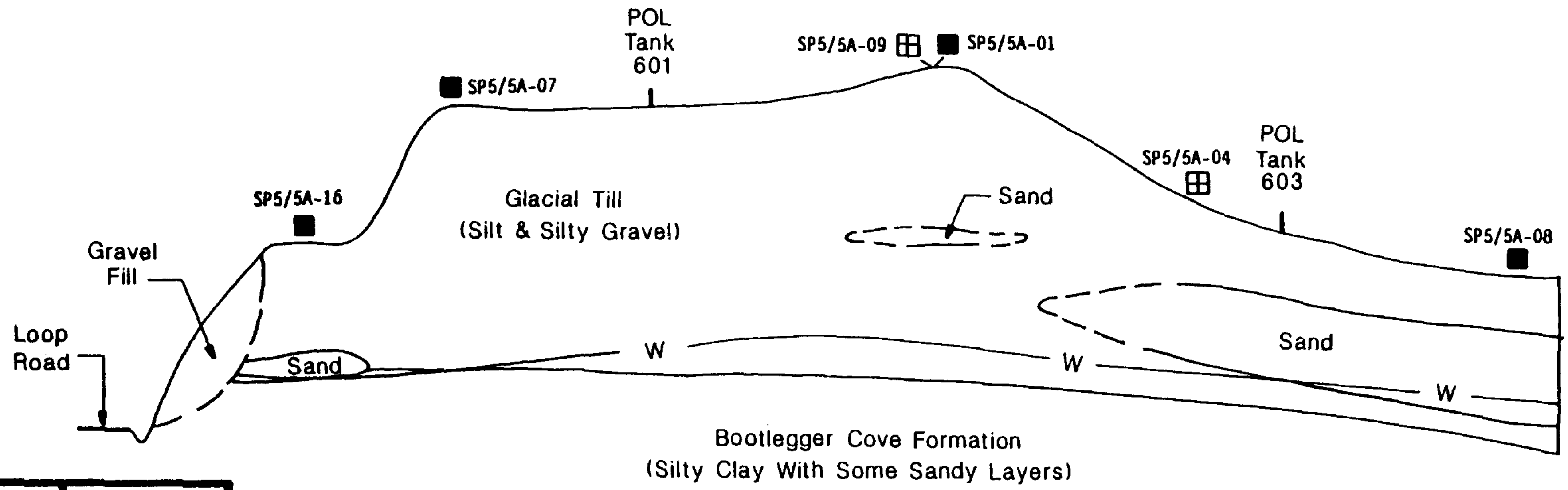
Figure 4.2.20.1

4.2.20.1.1 Site Geology

The SP-5/5A site is situated on hummocky ground straddling a ridge of unconsolidated sediments at the southern edge of the Elmendorf Moraine. These sediments, composed chiefly of glacial till and ice-marginal deposits, were laid down in an early advance of the Naptowne Glacier which occurred between 9,000 and 47,000 years before present. These sediments cover the entire site and consist mainly of discontinuous poorly-sorted, brown silty gravel and gravelly silts with minor discontinuous layers of well-sorted sands and gravels typical of ice-marginal deposits. Elevations at the site range from 225 feet to 275 feet.

The moraine overlies the Bootlegger Cove Formation (BCF) at variable depths across the site, typically 15 feet to 30 feet. A schematic geologic cross section is shown on Figure 4.2.20.2. The thickness of the BCF is about 100 feet in the vicinity of the site and includes several facies ranging from clay with very minor silt and sand constituents to sands and gravels with discontinuous layers of silt. The top of the BCF in the vicinity of Site SP-5/5A is typically irregular, probably due to erosion and/or effects of glacial override. The BCF was encountered in most of the borings and observation trenches and usually consisted of gray clayey silt or low to moderately plastic silty clay and acts as an aquitard to the shallow unconfined groundwater system located within the unconsolidated sediments above the BCF. At depth the BCF is underlain by coarse Pleistocene glaciofluvial deposits.

The surface of the POL site had been graded and supports a grass cover. The perimeter of the POL site had been previously graded but has been overgrown with dense alders to a height of 20 feet. The tank sludge burial site, as identified on Figure 4.2.20.1, is heavily overgrown with alders in the vicinity of borings SP5/5A-11, SP5/5A-12, and SP5/5A-13. Metallic debris was scattered on the surface near boring SP5/5A-13.



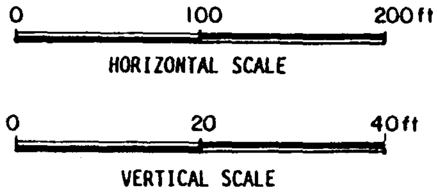
Legend:

SP5/5A-01 ■ Monitoring Well Location Stage 3

SP5/5A-09 ⊞ Stage 3 Borehole

—W— Projected Water Table

— — — Geologic Contact, Dashed Where Inferred



Notes:

1. Horizontal scale: 1 inch = 100 feet.
2. Vertical scale: 1 inch = 20 feet.
3. Geologic cross section shown on Figure 4.2.20.4

GEOLOGIC CROSS SECTION
SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.20.2

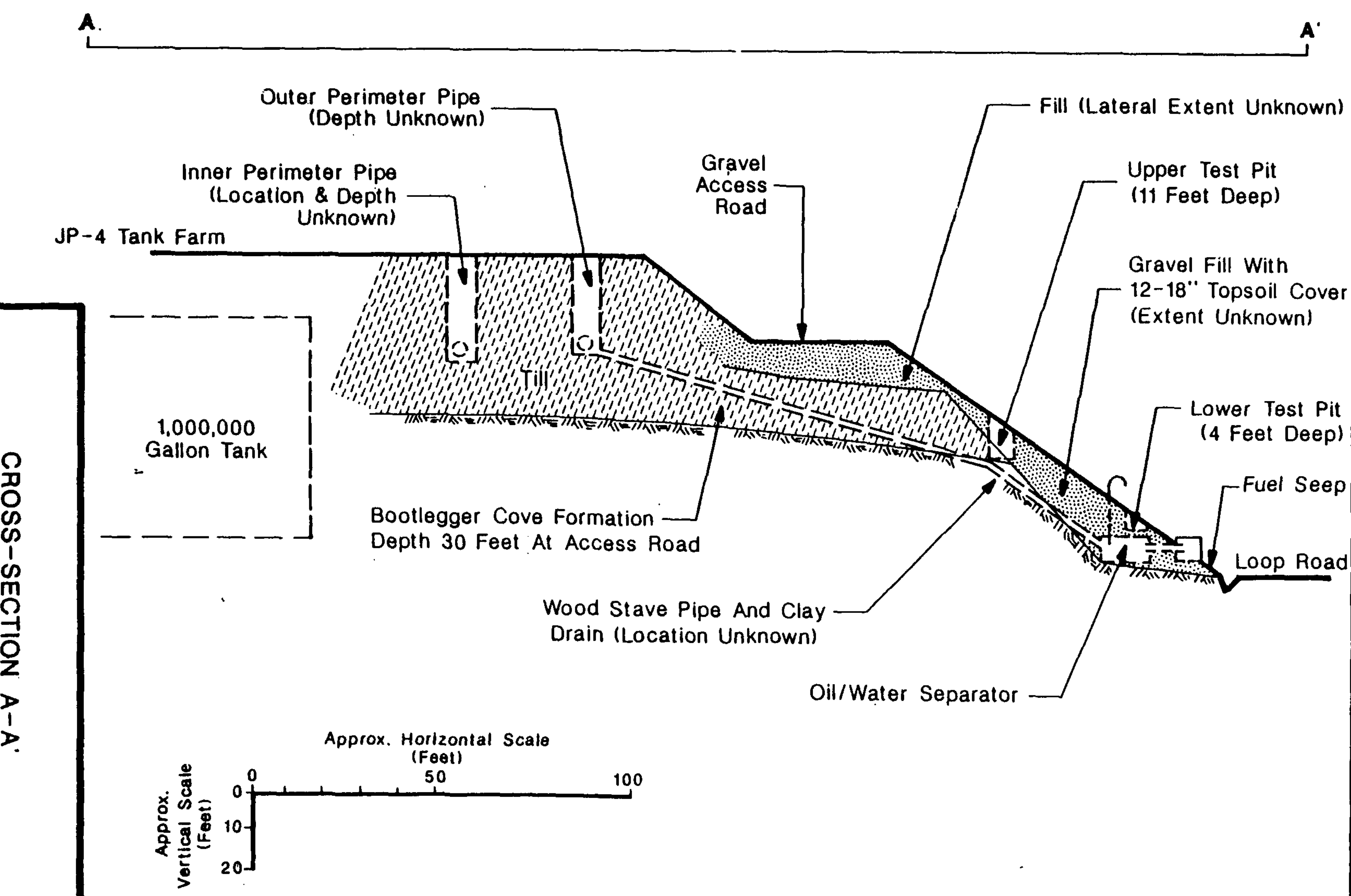
Twenty borings were drilled at Site SP-5/5A. Eleven of the borings were completed as monitoring wells. Site SP-5/5A boring logs are presented in Appendix C. Boring SP5/5A-10 was located in a swampy area to the northeast of the POL area and appeared to be a collection point for surface drainage from the northern portion of the POL tank farm. These logs detail the lithology and subsurface conditions encountered at each borehole. Gamma logging of wells SP5/5A-01, SP5/5A-08, and SP5/5A-15 are included in Appendix D.

4.2.20.1.1.2 Observation Trenches

Two observation trenches or pits were excavated immediately above Loop Road to investigate a drain and oil/water separator constructed at the base of the bluff to collect fuel from a spill in the early 1970s. Again, the oil/water separator is actually a 1000-gallon storage tank. Since the 1970's fuel has been observed seeping out of the bluff north of Loop Road. The location of the pits and separator and location of the cross section are presented on Figure 4.2.20.1 and the schematic cross section is presented on Figure 4.2.20.3.

The soils encountered in the upper pit consisted of 5 feet of dense compacted fill, consisting of native glacial till, overlying natural till which extended to a depth of 9 feet. ECF clay was encountered below the till. Total depth of the pit was 11 feet. The clay had a very slight fuel odor. Both the fill and native till had fuel stains with no associated odor. Neither groundwater nor wet soils were encountered above the clay layer.

The soil encountered in the lower pit consisted of foot of silty topsoil fill overlying gravel fill. The gravel fill was apparently saturated with fuel which flowed into the pit at sufficient rate to collapse the walls of the pit when the pit depth reached about four feet.



CROSS-SECTION A-A'
SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.20.3

4.2.20.1.1.3 Geophysical Investigation

The surficial geophysical investigation conducted at Site SP-5/5A focused on delineating underground tank boundaries and the extensive buried utilities for the purpose of establishing boring locations. A Ground Penetrating radar survey was performed to delineate subsurface geologic units but was not capable of differentiating units at the POL site.

A terrain conductivity survey was conducted in the Tank Sludge Burial Area to detect buried debris where debris were not already visible on the ground surface. Results of the terrain conductivity survey conducted in the Tank Sludge Burial Area are presented in Appendix D.

Subsurface geophysical surveys, natural gamma logs, were performed in 3 borings within the SP-5/5A site. The locations include SP5-/5A-02, SP5/5A-08, and SP5/5A-15.

The gamma log at SP5/5A-02 as presented in Appendix D indicates that the uppermost soil layer was layered with sandy or gravelly horizons and possibly contains cobbles and boulders. This soil unit appeared to have a relatively sharp contact with the layer below interpreted as a silt or clay-rich unit containing gravel. The high silt or clay content inferred from the gamma log suggested that this layer may act as an aquitard, reducing the infiltration of surface water to greater depths. The gamma log also showed that this zone is about eight feet thick. The lowest soil unit logged appeared to consist of relatively uniform grain size, interpreted to be composed of silt, sand and gravel.

The gamma log of SP5/5A-08 as presented in Appendix D was interpreted to show a silt rich layer between 7 and 12 feet that overlies a more sandy layer. The soil unit between 16 and 26 feet appeared to be sand or gravel that was probably layered. This zone was interpreted to be

thicker on the basis of the gamma log than what was interpreted from borehole logging of grab samples.
The gamma log of SP5A-15 as presented in Appendix D was interpreted to consist of a silt- or clay-rich layer that extends to about 13 feet below the ground surface. The gamma log for the lower portion of the borehole contrasted with the boring log and was interpreted to be a sand or gravel layer that was probably layered and became finer-grained upward.

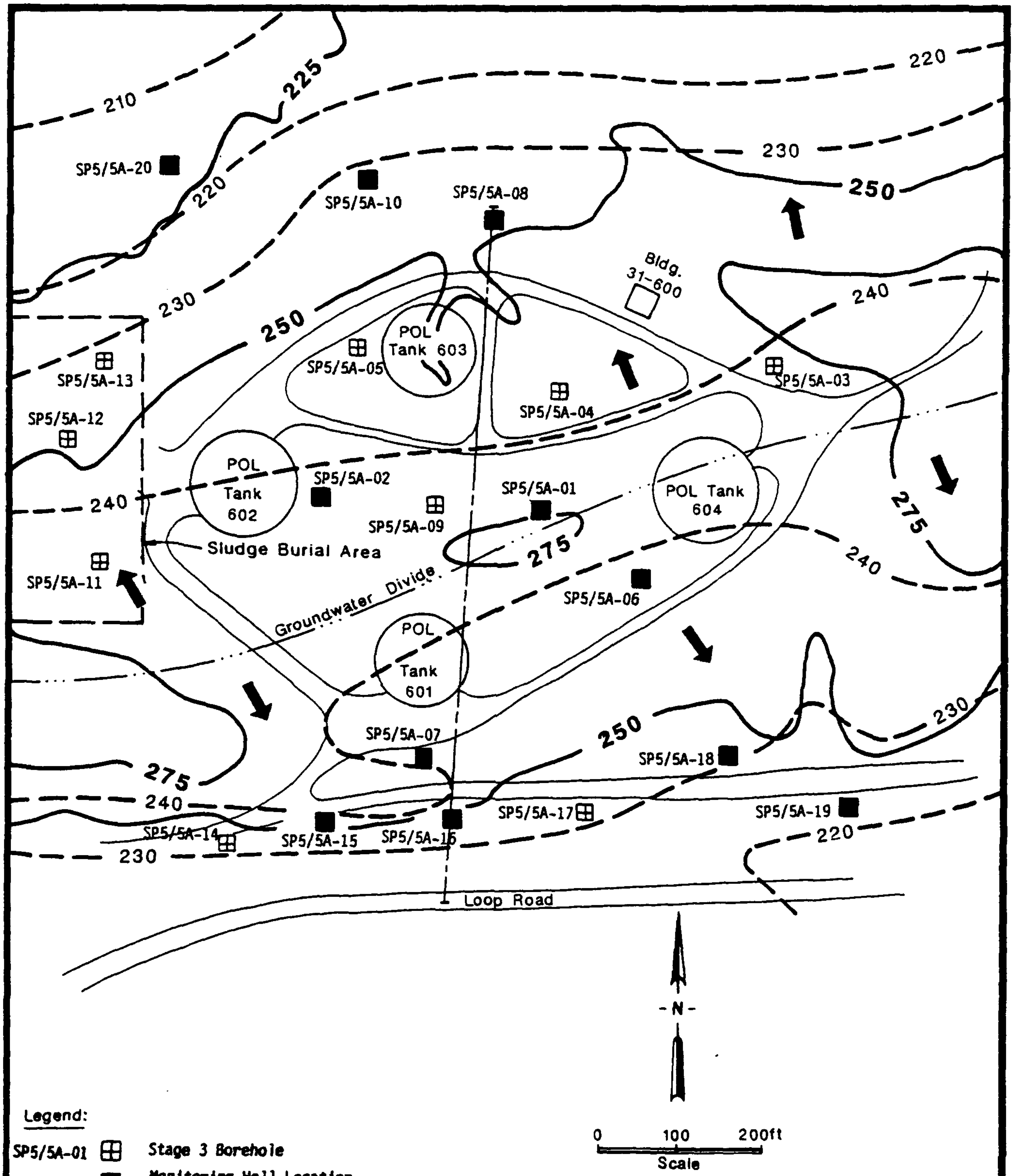
Complete gamma logs of each run are provide in Appendix D.

4.2.20.1.2 Site Hydrogeology

Groundwater was obtained from monitoring wells at Site SP-5/5A that tapped discontinuous units of silty sand, silty sandy gravel and sandy silt within the till and unconsolidated deposits above the Bootlegger Cove Formation. Figure 4.2.20.4 presents water table contours of the area constructed from water level data collected during July and August of 1988.

Site SP-5/5A is underlain by an approximately east-west trending groundwater divide. South of the divide, groundwater generally flows southward, and north of the divide, groundwater flows northward.

Hydraulic conductivity measurements performed in 4 wells at Site SP-5/5A are presented on Figure 4.2.20.5 and range from 5.3×10^{-2} feet per day to 1.8 feet per day. Use of slug test methodology at well SP5/5A-08 was not possible because the water level response was too rapid. These values may not represent the full range of hydraulic conductivities within the area, considering the fact that several boreholes were drilled that did not yield sufficient amounts of water to merit completion as monitoring wells. Also, considering the heterogeneity of the deposits, units of significantly higher hydraulic conductivity may occur.



Legend:

SP5/5A-01 ⊞ Stage 3 Borehole

SP5/5A-09 ■ Monitoring Well Location Stage 3

--220-- Water table contour. Contour intervals: 10ft.

➚ Approximate direction of groundwater flow.

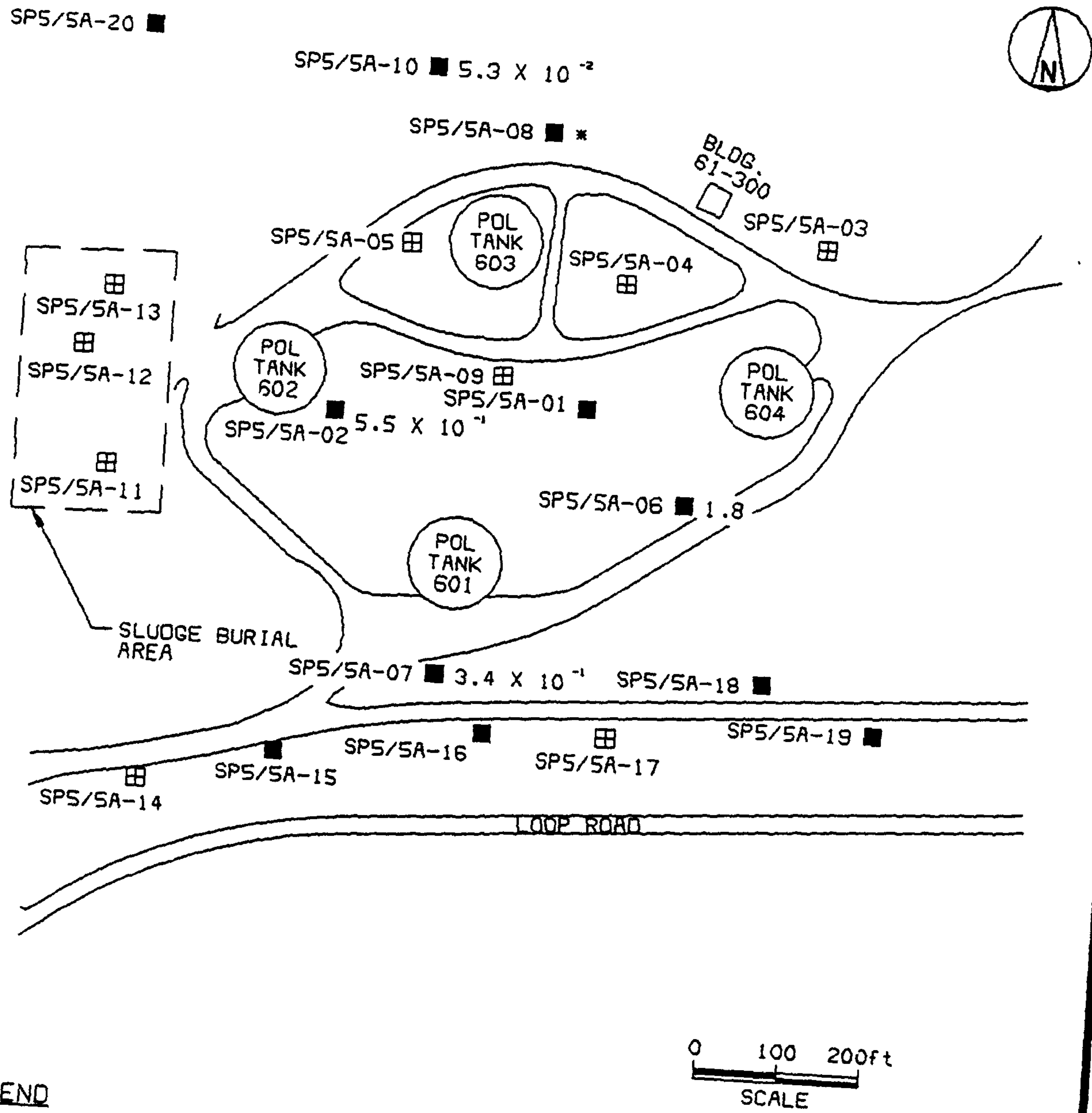
—250— Land surface elevation contour. Contour intervals: 25ft.

├ - - - ┤ Geologic Cross Section

HYDROGEOLOGIC MAP
SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.20.4



LEGEND

WELL NUMBER
WELL LOCATION
HYDRAULIC CONDUCTIVITY (FT/DAY)

SP5/5A-01 ⊞ 1.8

⊞ SP5/5A-01 BORING LOCATION

■ SP5/5A-03 BORING COMPLETED AS A MONITORING WELL

* WATER LEVEL RESPONSE TO RAPID FOR METHODOLOGY

HYDRAULIC CONDUCTIVITY

SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.20.5

4.2.20.1.3 Analytical Results

Field analytical results and observations and laboratory analytical results are discussed in the following sections.

4.2.20.1.3.1 Field Analytical Results and Observations

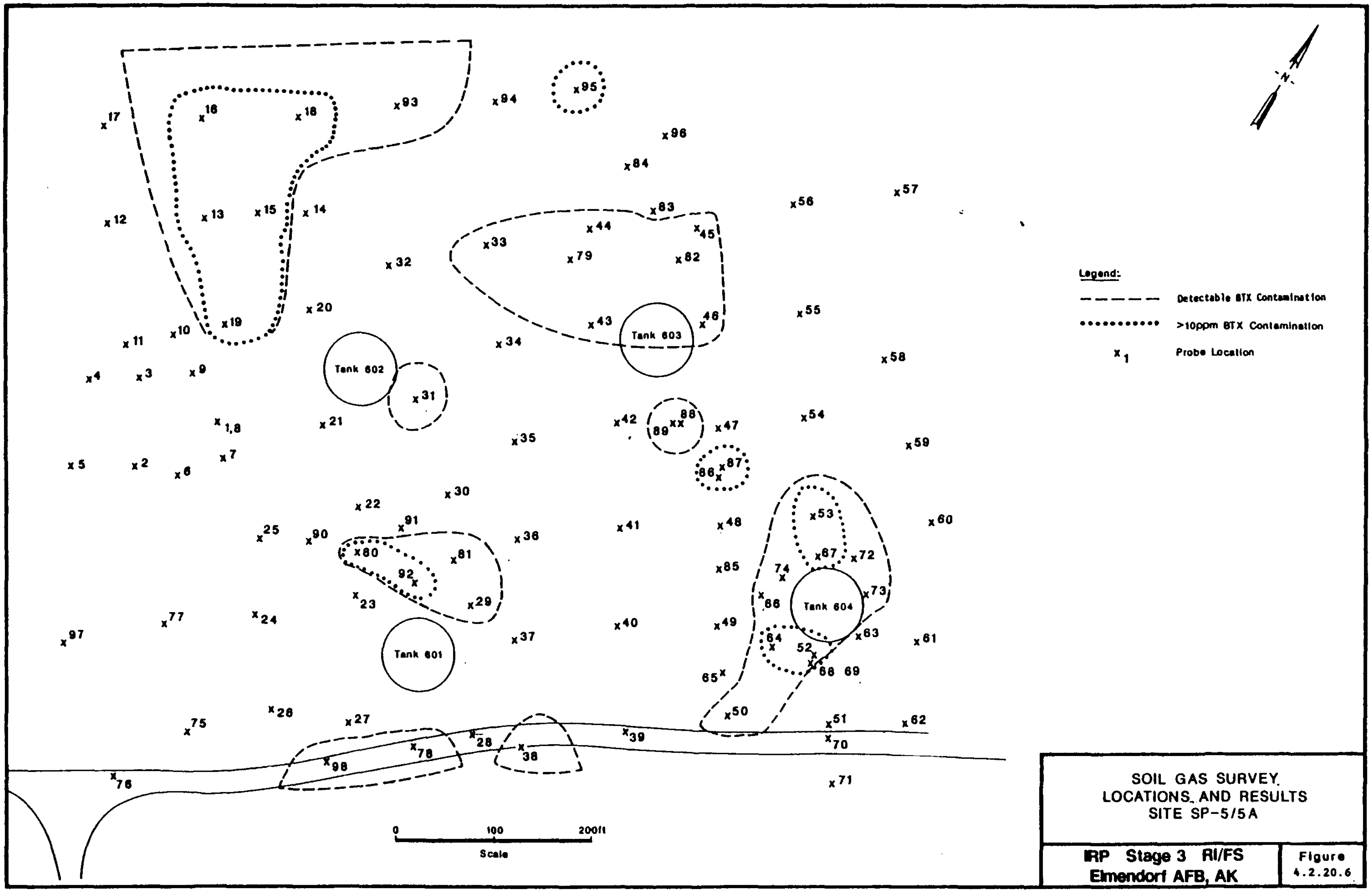
Results of the soil gas survey conducted at site SP-5/5A are presented on Figure 4.2.20.6 and Table 4.2.20.1. Isoconcentration contours have been drawn based on the findings of the field analysis.

In addition to logging the stratigraphy at each boring, a determination of the presence of potential contamination was assessed. The boreholes with evidence of probable contamination based on fuel odors, soil stains, visual evidence of floating fuel or HNu readings are discussed below:

- Well SP5/5A-01 - None of the samples to a depth of 40 feet exhibited HNu readings. The soil samples taken between 40 feet and 45 feet had HNu readings of 8 to 9 ppm. The last soil sample taken at 45 feet had 9 inches of BCF clay in the bottom of the sample which gave no HNu reading. Groundwater was encountered in the sand-gravel lense between 39 and 46 feet.

- Well SP5/5A-06 - The soil samples taken between 5 and 25 feet had no HNu readings while the soil sample at 40 feet had a reading of 3 ppm. During drilling, groundwater was encountered in the sandy-silt at a depth of 41 feet.

- Well SP5/5A-07 - An HNu reading of 2 ppm was measured inside the auger at a depth of 55 feet. Groundwater was encountered at 47 feet during drilling.



SOIL GAS SURVEY,
LOCATIONS, AND RESULTS
SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.20.6

Table 4.2.20.1 Summary of Soil Gas Chromatograph Analyses at Site SP5

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Comments
1	8	-	-	-	
2	10	-	-	-	
3	5	.67	-	-	
4	5	-	-	-	
5	5	-	-	-	
6	5	-	-	-	
	10	-	-	-	
7	5	-	-	-	
8	5	-	-	-	
9	5	-	-	-	
10	5	-	-	-	
11	5	-	-	-	
12	5	-	-	-	
13	5	-	3300	-	JP4
	10	-	39	-	JP4
	15	-	32	-	JP4
14	5	-	-	-	
	10	-	13	-	
15	5	-	120	-	JP4
16	5	-	1947	-	JP4; oily water to surface
17	5	-	-	-	
18	5	7	34	-	
19	10	-	88	-	
20	5	-	-	-	
	10	-	-	-	
21	10	-	TR	-	
22	5	-	-	-	
	10	-	-	-	
23	10	-	-	-	
24	5	-	-	-	
	10	-	-	-	
25	10	-	-	-	
26	5	-	-	-	
	10	-	-	-	
27	10	-	-	-	
28	5	-	-	-	
	10	-	-	-	
20	10				
30	5	-	-	-	
	10	-	-	-	
31	10	-	1	TR	
32	10	-	-	-	
33	10	-	3	-	

Table 4.2.20.1 Summary of Soil Gas Chromatograph Analyses at Site SP5 (Cont'd.)

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Comments
34	10	-	-	-	
35	10	-	-	-	
36	10	-	-	-	
37	10	-	-	-	
38	10	1	-	-	
39	10	-	-	-	
40	10	-	TR	TR	
41	10	-	-	TR	
42	10	-	-	TR	
43	8.5	-	-	12	Toluene masked by xylene peak
44	10	-	2	-	Benzene masked by toluene peak
45	10	2	TR	-	
46	5	1	-	-	
47	10	-	-	-	
48	10	TR	TR	-	
49	10	-	-	-	
50	9	-	1	1	
51	10	-	-	-	
52	10	-	50	24	JP4 and water to surface
53	10	-	42	-	
54	10	-	-	-	
55	10	-	TR	-	
56	5	-	TR	TR	
	10	-	-	TR	
57	10	-	-	TR	
58	10	-	-	TR	
59	10	-	.4	-	
60	10	-	TR	TR	
61	10	-	-	-	
62	10	-	-	-	
63	10	-	-	-	
64	10	-	26	29	
65	10	-	1	TR	
66	10	-	15	6	
67	10	-	3	-	
68	10	-	TR	TR	
69	15	1	-	-	
70	15	-	-	-	
71	12.5	-	-	-	
72	5	2	-	-	
73	10	-	2	TR	

Table 4.2.20.1 Summary of Soil Gas Chromatograph Analyses at Site SP5 (Cont'd.)

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Comments
74	10	-	TR	7	
75	7.5	-	-	-	
76	10	-	-	-	
77	7	-	-	-	
78	5	-	1	TR	
79	10	0	TR	TR	
80	5				
81	5	2	-	-	
82	5	-	-	TR	
83	5	-	-	-	
84	5	-	-	-	
85	10	-	-	-	
86	6	-	202	TR	JP4
87	5				
88	10	TR	TR	TR	
89	5	4	TR	-	
90	5	TR	TR	TR	
91	5	-	TR	TR	
92	5	-	280	538	JP4
93	5	-	1	3	
94	9.5	-	-	TR	
95	5	-	29	39	JP4
96	10	-	1	3	
97	10	-	-	-	
98	5	-	1	-	

TR - Trace

- o Well SP5/5A-09 - An HNu reading of 10-15 ppm was recorded from the soil sample taken at 30 feet (30-31.5 feet), and the sample had a strong fuel odor. The lower 6 inches of the next soil sample taken for a chemical duplicate analysis (at 31.5-33 feet) had no HNu readings. The BCF clay was present in the bottom 9 inches of the sample taken from 40-41.5 feet. At the contact between the BCF and the overlying clay, the sandy-clay had an HNu reading of 1 ppm with a strong fuel odor. There was no indication of contamination in the BCF.

- o Well SP5/5A-10 - The soil samples taken from 0.4 feet to 3.5 feet had strong fuel odors and HNu readings of 100 to 720 ppm. The soil sample taken at the groundwater interface (5-6.5 feet) also had strong fuel odors and HNu readings of 150 ppm. An HNu reading of 3 ppm was recorded in the soil sample taken from 10 feet and 12 ppm in the sample from 13.5 - 15 feet. HNu readings in the augers during drilling ranged from 30 to 150 ppm, and in the breathing zone during drilling readings ranged from 1/2 to 3 ppm.

- o Well SP5/5A-13 - An HNu reading of 0.2 ppm with no odor was recorded in soil samples and cuttings taken from zero to 2 feet. From 2 to 5 feet depth there were strong fuel odors and HNu readings in the samples and cuttings from 100 to 170 ppm.

- o Well 20 - An HNu reading of 1 ppm was recorded in the first sample (0-1.5 feet).

Site SP-5A - This site, as indicated on the Figure 4.2.20.1, is located south of SP-5 along the access road. It is also the location of the main fuel transmission lines to the storage facility and to the base.

- o Well SP5/5A-15 - A 1 foot fill for the access road was present. HNu readings were observed throughout the borehole starting with

2 ppm in the fill, 100 ppm for the first soil sample (5-6.5 feet), 2 to 15 ppm for the second soil sample just below the groundwater interface (11-12.5 feet), 200 ppm measured in the augers at 11-12.5 feet, 8 ppm in the augers at 15 feet, 20 ppm in the third soil sample (15-16.5 feet) and 15 ppm in the upper 6 to 8 inches of the last soil sample (20-21.5 feet). Strong fuel odors were present during the drilling operations.

- Well SP5/5A-16 - An HNu reading of 1 ppm was detected in the soil sample at 10 feet. Fuel odors and a reading of 100 ppm were observed in the soil sample taken at 15 feet.

- Well SP5/5A-17 - The following HNu readings were recorded on soil samples at the following depths: 10-11.5 feet-2 ppm; 15-16.5 feet-130 ppm; 20-21.5 feet-7 ppm; 25-26.5 feet-10 ppm. Strong fuel odors were evidenced from soil samples and cuttings from 10 feet to the bottom of the boring.

- Well SP5/5A-18 - Contamination was indicated by an HNu reading of 3 ppm in a soil sample at a depth of 10 feet. No fuel odors or other indications of contamination were observed.

- Well SP5/5A-19 - An HNu reading of 14 ppm was observed at 15 feet. No fuel odors or other indications of contaminants were noted.

Field observations of the test pit excavations are presented in Section 4.2.20.1.1.

Field parameters measured at Site SP-5/5A during groundwater sampling are provided on Table 4.2.20.2.

The laboratory analytical program for Site SP-5/5A is presented in Table 4.2.20.3 and the sample plan for the base-wide field

Table 4.2.20.2 Field Parameters at Site SP-5/5A

Well Number	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
SP5/5A-01	08/04/88	7.5	605	7.32	489	No odor or sheen
SP5/5A-02	07/19/88	9.9	720	7.13	469	No odor or sheen
SP5/5A-06	08/04/88	7.0	580	7.17	400	No odor or sheen
SP5/5A-07	08/05/88	5.9	700	7.63	560	Slight odor; no sheen
SP5/5A-08	08/04/88	6.5	255	7.42	203	No odor or sheen
SP5/5A-10	08/05/88	7.5	620	7.47	720	Strong odor; sheen
SP5/5A-15	08/05/88	8.5	820	8.57	634	Slight odor; no sheen
SP5/5A-16	08/05/88	7.0	1020	7.86	1094	Strong odor; pure product on surface
SP5/5A-18	07/19/88	8.5	380	6.17	170	No odor or sheen
SP5/5A-19	08/05/88	6.5	350	7.09	258	Slight odor; no sheen
SP5/5A-20	08/29/88	7.0	360	7.06	198	Slight sulfur odor; no sheen

TABLE 4.2.20.3 REQUESTED LABORATORY ANALYSIS FOR SAMPLES FROM SITE SP-5/5A

SOIL/SEDIMENT

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
8240	Volatile Organics
160.3	Moisture (Total Solids)

WATER

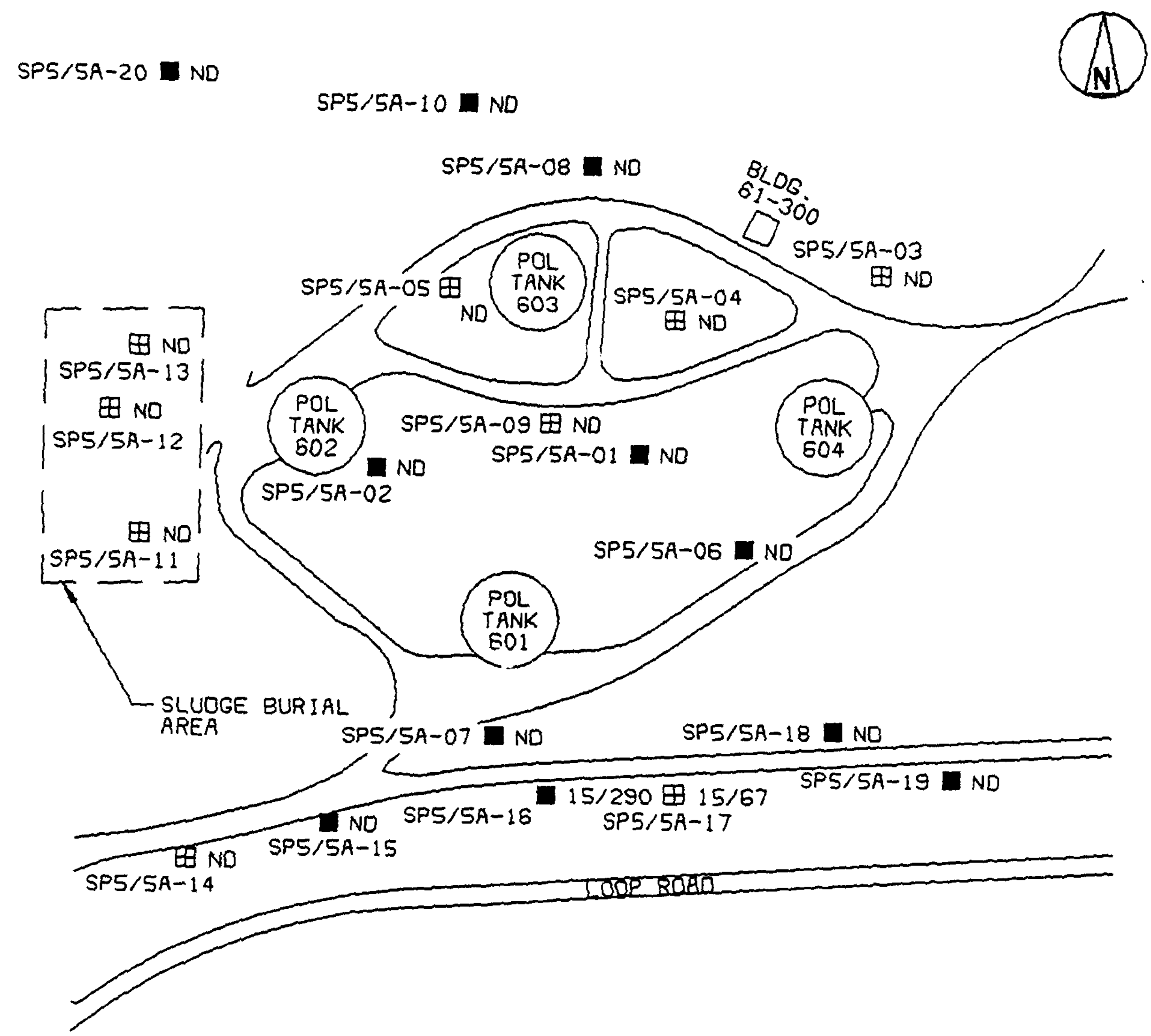
Test Number	Analysis
418.1	Total Petroleum Hydrocarbons
602	Purgeable Aromatics

investigation program is included in Appendix B. Major contaminants identified from the laboratory analysis of samples collected at Site SP-5/5A are plotted on Figures 4.2.20.7 through 4.2.20.13. There is a separate identified contaminant, with the analyte concentrations plotted next to the corresponding well or test boring. The depth where the concentration level occurred is also included for the soil samples; however, isoconcentration lines were not attempted due to the few points registering detectable contamination for each analyte. All of the laboratory analytical results for site SP-5/5A are presented in Table 4.2.20.4.

Volatile organic compounds, specifically benzene, ethylbenzene, toluene, xylenes (BETX), were prevalent at Site SP-5/5A. Concentrations of these identified contaminants for water ranged from 68 ug/L total BETX at well SP5/5A-10 to 60,600 ug/L total BETX at well SP5/5A-16. BETX contamination of the soils was undetected in most borings. Detected values ranged from 1.7 mg/kg total BETX found at boring SP5/5A-17, to 40.3 mg/kg total BETX at well SP5/5A-16.

The area of highest BETX contamination levels occurred south-southeast of POL Tank 601. Two areas with lower BETX contamination occurred southeast of POL Tank 601 parallel to Loop Road and north-northwest of POL Tank 603.

Other volatile organic compounds, including methylene chloride and ethanol were detected in soil samples at Site SP-5/5A, although these levels were generally low and isolated to 1 or 2 boring sites. Methylene chloride was noted at 2 different wells, SP5/5A-16 and SP5/5A-17. Concentrations were 6.0 mg/kg and 2.5 mg/kg, respectively. Ethanol was observed in the soil at well SP5/5A-19 at a concentration level of 0.26 mg/kg.



LEGEND

- BORING/WELL NUMBER
- BORING/WELL LOCATION
- DEPTH OF SAMPLE
- ANALYTE CONCENTRATION
  - SOIL: mg/kg
  - WATER: ug/L
  - ND: non-detected

SPS/5A-01 (SYMBOL) 10/300

⊞ SPS/5A-01 STAGE 3 BOREHOLE

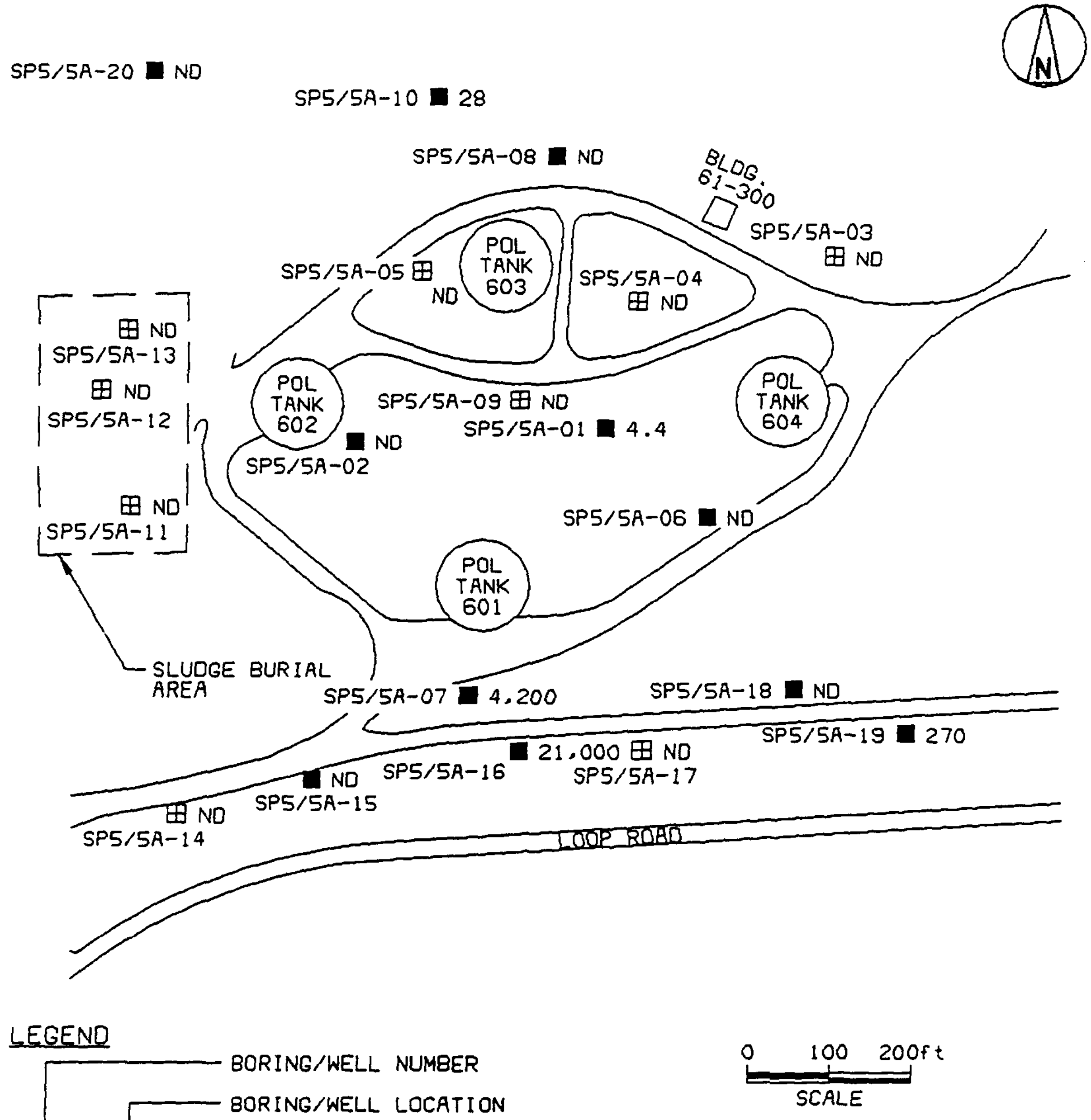
■ SPS/5A-03 MONITORING WELL LOCATION, STAGE 3

NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.20.7



LEGEND

- BORING/WELL NUMBER
- BORING/WELL LOCATION
- DEPTH OF SAMPLE
- ANALYTE CONCENTRATION
  - SOIL: mg/kg
  - WATER: ug/L
  - ND: *non-detected*

SP5/5A-01 (SYMBOL) 10/300

⊞ SP5/5A-01 STAGE 3 BOREHOLE

■ SP5/5A-03 MONITORING WELL LOCATION, STAGE 3

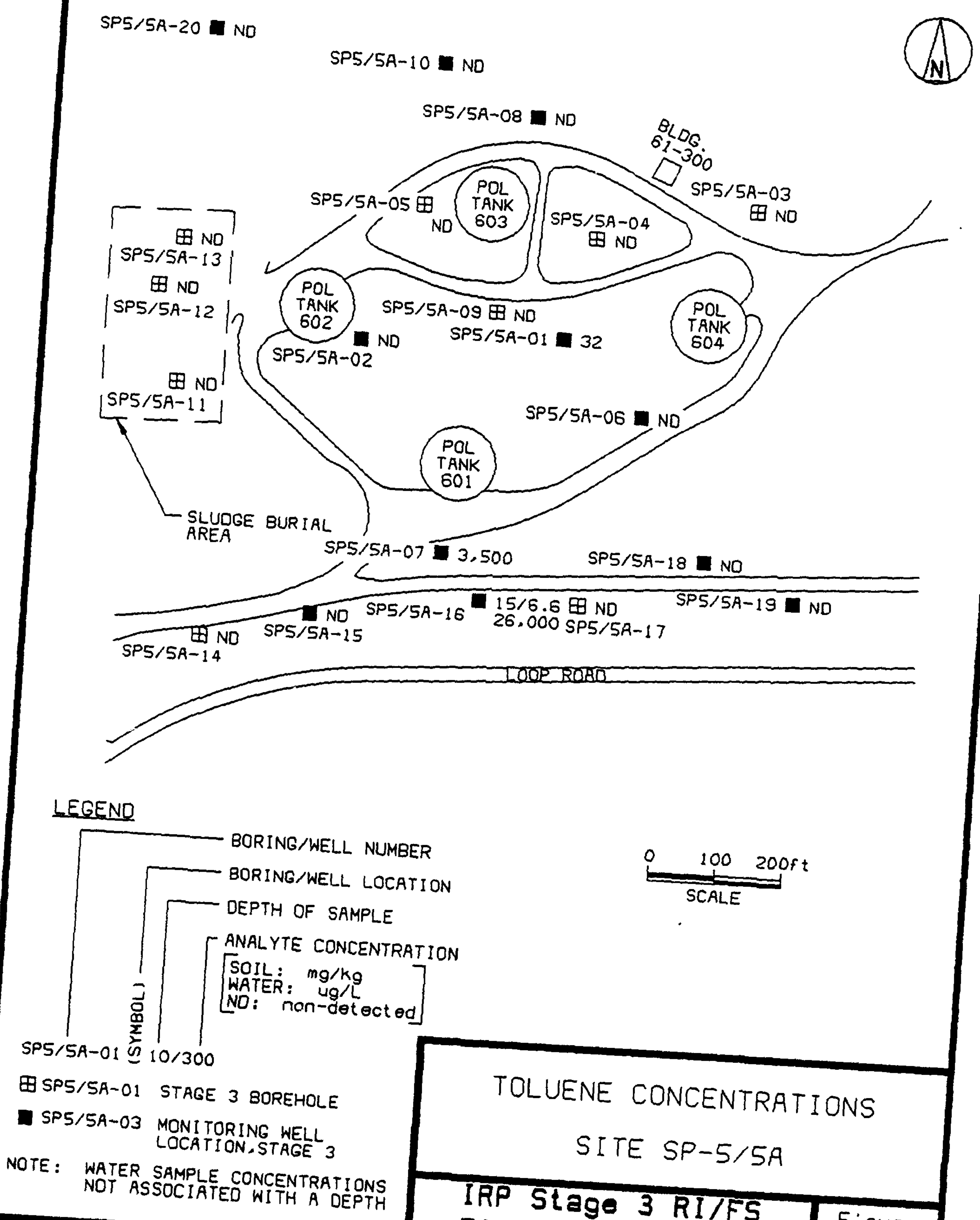
NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

BENZENE CONCENTRATIONS

SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.20.8

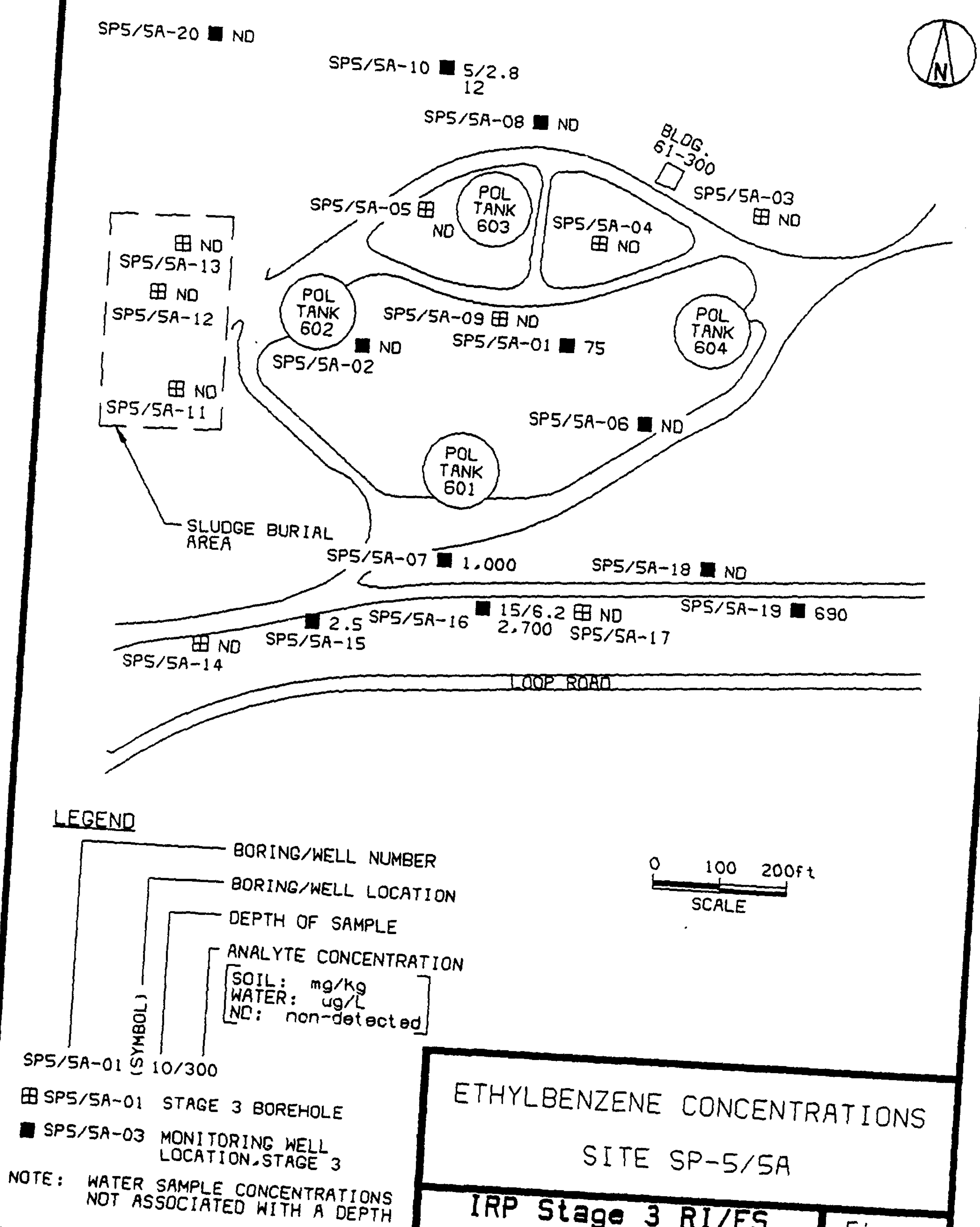


TOLUENE CONCENTRATIONS

SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.20.9

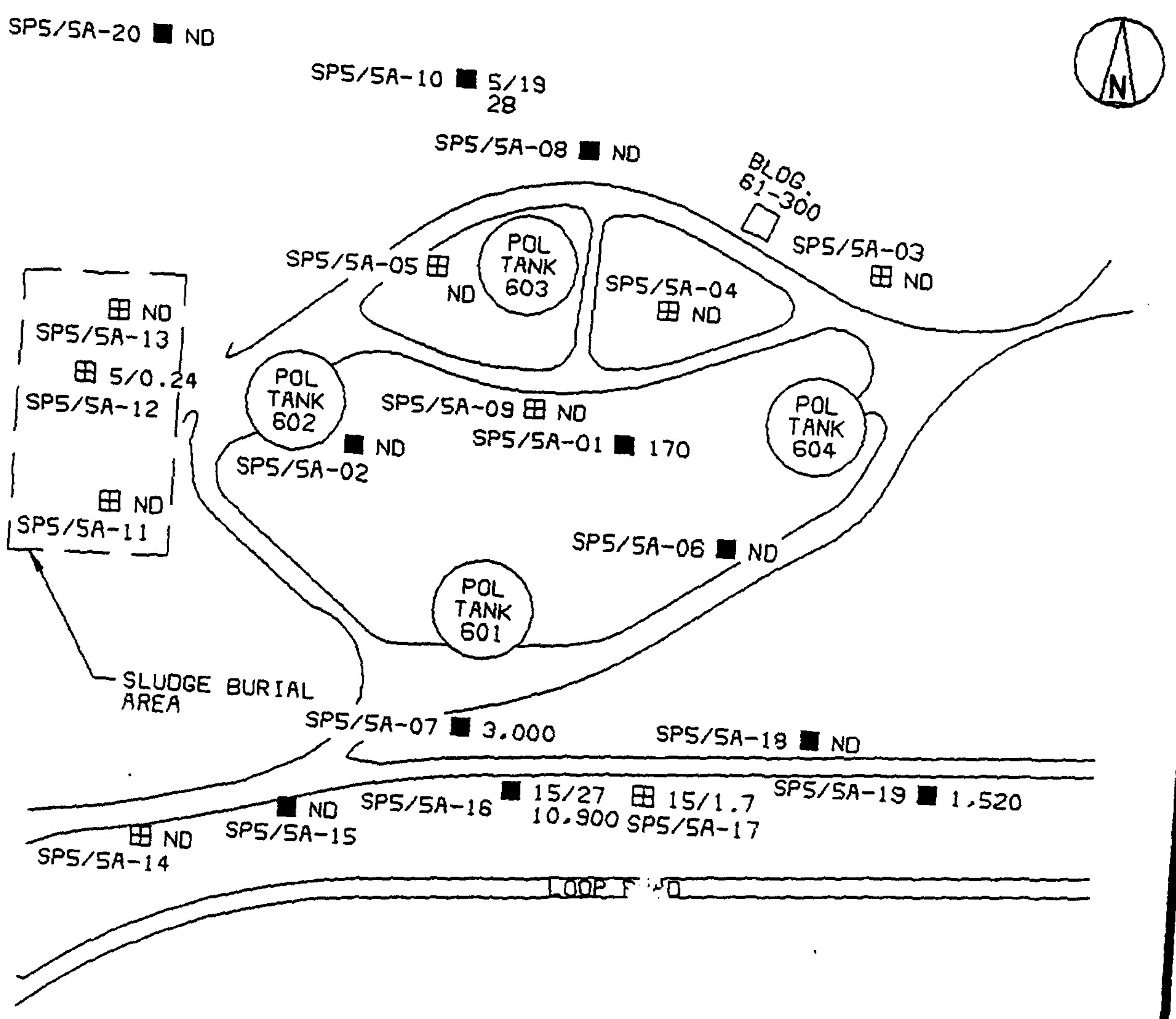


ETHYLBENZENE CONCENTRATIONS

SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.20.10



LEGEND

SPS/5A-01 (SYMBOL) 10/300

- BORING/WELL NUMBER
- BORING/WELL LOCATION
- DEPTH OF SAMPLE
- ANALYTE CONCENTRATION
  - SOIL: mg/kg
  - WATER: ug/L
  - ND: non-detected

⊞ SPS/5A-01 STAGE 3 BOREHOLE

■ SPS/5A-03 MONITORING WELL LOCATION, STAGE 3

NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

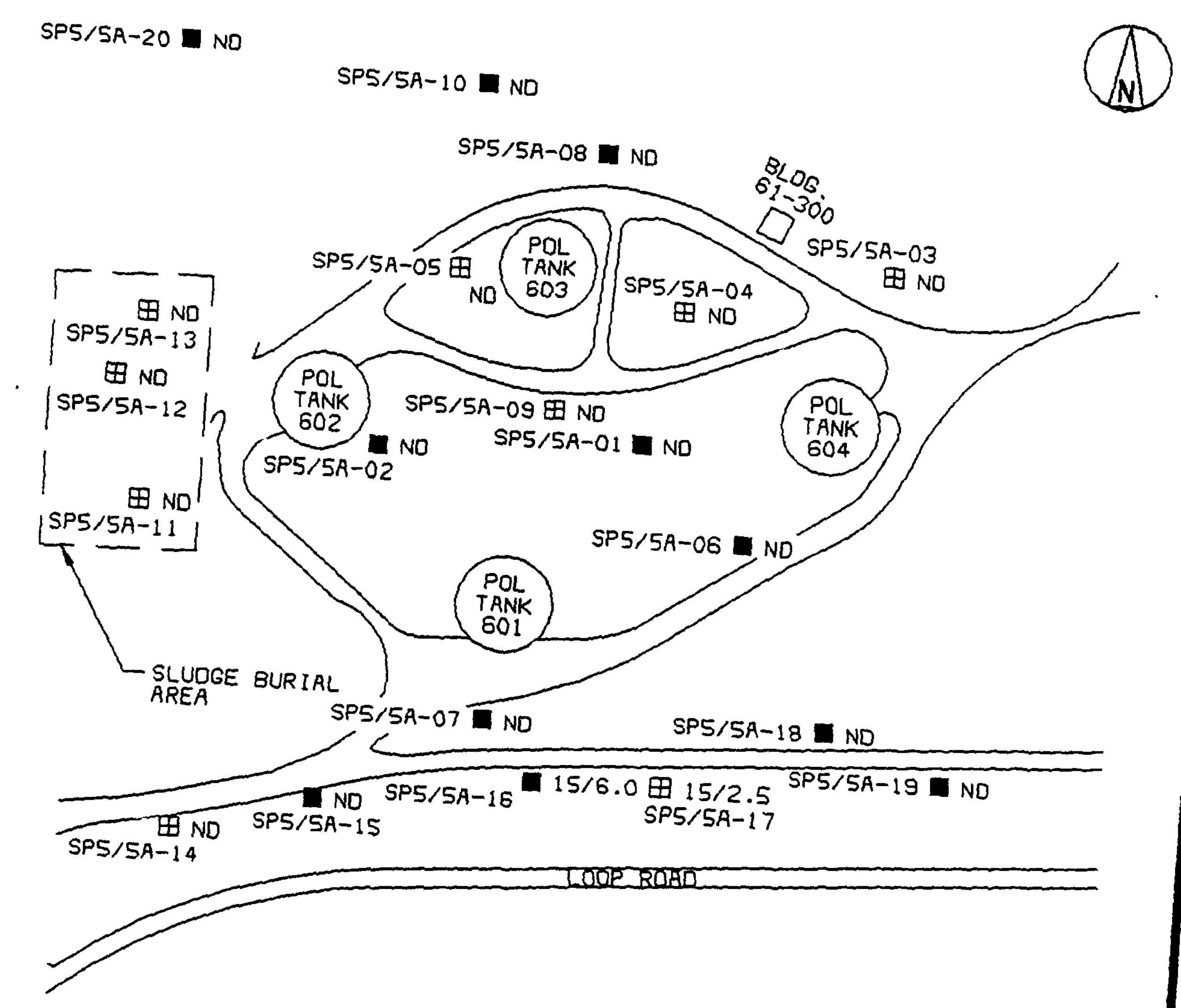
0 100 200ft
SCALE

TOTAL XYLENES CONCENTRATIONS

SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.20.11



LEGEND

BORING/WELL NUMBER
BORING/WELL LOCATION
DEPTH OF SAMPLE
ANALYTE CONCENTRATION
SOIL: mg/kg
WATER: ug/L
ND: non-detected

SPS/SA-01 (SYMBOL) 10/300

⊞ SPS/SA-01 STAGE 3 BOREHOLE

■ SPS/SA-03 MONITORING WELL LOCATION, STAGE 3

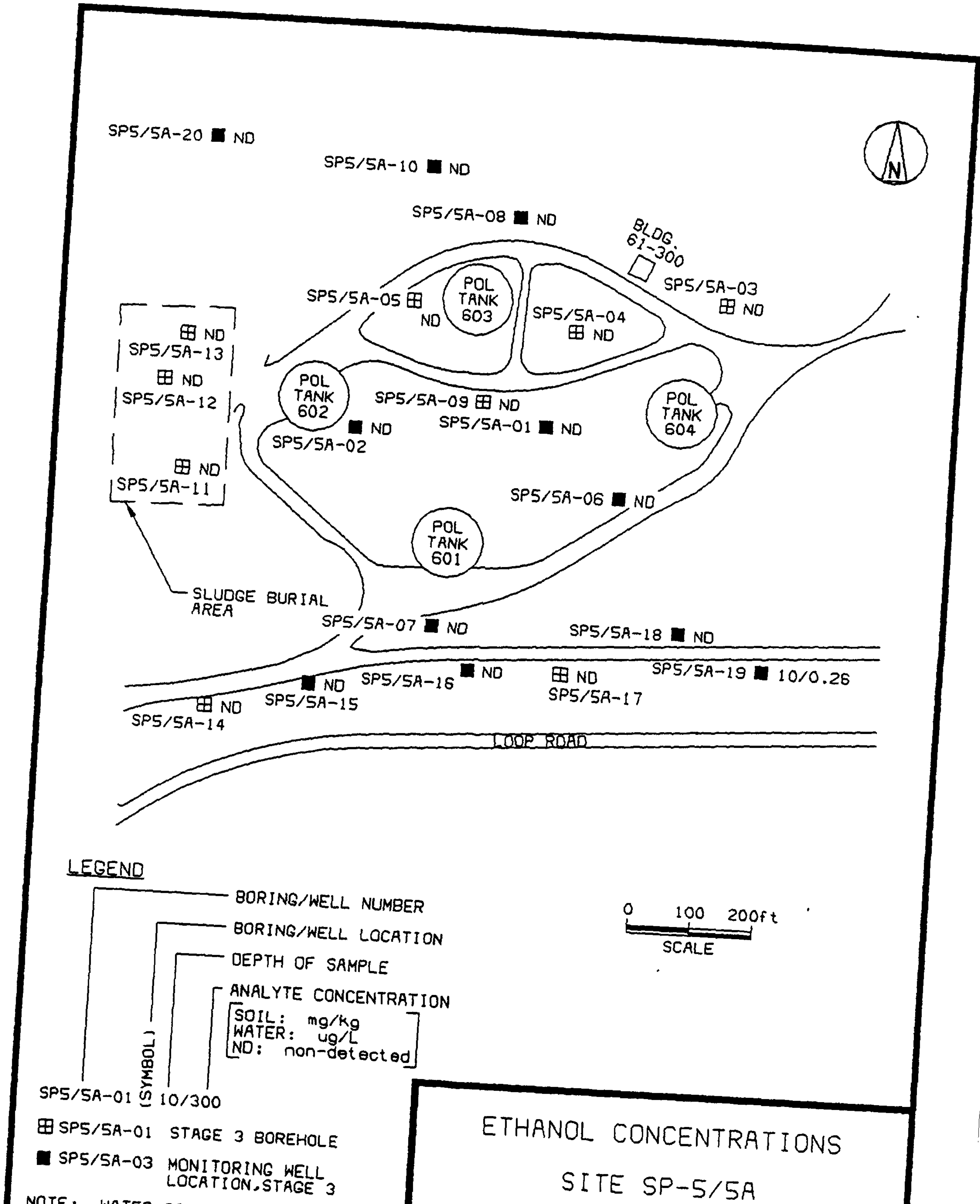
NOTE: WATER SAMPLE CONCENTRATIONS NOT ASSOCIATED WITH A DEPTH

0 100 200ft
SCALE

METHYLENE CHLORIDE CONCENTRATIONS SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.20.12



ETHANOL CONCENTRATIONS
SITE SP-5/5A

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.20.13

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP5/5A-14 10'-11.5' 0687-SO-066 GS-88-0001 000768-0005	SP5/5A-14 15'-17' 0687-SO-066 GS-88-0002 000768-0006	SP5/5A-14 15'-17' DUPLICATE 0687-SO-066 GS-88-0002 000768-0006	SP5/5A-15 5'-6.5' 0687-SO-067 GS-88-01 000746-0006	SP5/5A-15 10'-11.5' 0687-SO-067 GS-88-02 000746-0007	SP5/5A-15 15'-16.5' 0687-SO-067 GS-88-03 000746-0008
Benzene	EPA 602	ug/L	5.0						
Ethanol	Method 8240	mg/kg							
Ethyl benzene	EPA 602	ug/L	700						
Methylene chloride	Method 8240	mg/kg							
Toluene	Method 8240	mg/kg	15,000						
Total Dissolved Solids	160.1	mg/L	500						
Total Petroleum Hydrocarbons	3550/418.1 Mod.								
Total Solids	160.3	%		91.1	89.4	89.7	94.0	86.6	85.1
Total xylenes	Method 8240	mg/kg	500						
m-Xylene	EPA 602	ug/L	440						
o & p-Xylene(s)	EPA 602	ug/L	440						

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP5/5A-15 20'-21.5' 0687-SO-067 GS-88-04 000746-0009	SP5/5A-15 0687-NG-067-GN-88-0005 001121-0006	SP5/5A-16 0687-NG-068-GN-88-0004 001121-0007	SP5/5A-16 5'-6.5' 0687-SO-068 GS-88-01 000746-0011	SP5/5A-16 10'-11.5' 0687-SO-068 GS-88-02 000746-0012	SP5/5A-16 10'-11.5'DUPLICATE 0687-SO-068 GS-88-02 DU 000746-0012
Benzene	EPA 602	ug/L	5.0			21000.			
Ethanol	Method 8240	mg/kg							
Ethyl benzene	EPA 602	ug/L	700		2.5	2700.			
Methylene chloride	Method 8240	mg/kg							
Toluene	Method 8240	mg/kg	15,000			26000.			
Total Dissolved Solids	160.1	mg/L	500						
Total Petroleum Hydrocarbons	3550/418.1 Mod.								
Total Solids	160.3	%		86.3			86.5	87.3	86.8
Total xylenes	Method 8240	mg/kg	500						
m-Xylene	EPA 602	ug/L	440			6200.			
o & p-Xylene(s)	EPA 602	ug/L	440			4700.			

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP5/5A-16 15'-16.5' 0687-SO-068 GS-88-03 000746-0013	SP5/5A-17 10'-11.5' 0687-SO-069 GS-88-01 000746-0014	SP5/5A-17 15'-16.5' 0687-SO-069 GS-88-02 000746-0015	SP5/5A-17 20'-21.5' 0687-SO-069 GS-88-03 000746-0016	SP5/5A-18 0687-NG-070 GN-88-04 000837-0004	SP5/5A-18 5'-6.5' 0687-SO-070 GS-88-01 000746-0001
Benzene	EPA 602	ug/L	5.0						
Ethanol	Method 8240	mg/kg							
Ethyl benzene	EPA 602	ug/L	700	6.2					
Methylene chloride	Method 8240	mg/kg		6.0		2.5			
Toluene	Method 8240	mg/kg	15,000	6.6					
Total Dissolved Solids	160.1	mg/L	500					520	
Total Petroleum Hydrocarbons	3550/418.1 Mod.			286		67			
Total Solids	160.3	%		91.0	90.5	89.5	89.0		84.0
Total xylenes	Method 8240	mg/kg	500	27		1.7			
m-Xylene	EPA 602	ug/L	440						
o & p-Xylene(s)	EPA 602	ug/L	440						

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP5/5A-18 10'-11.5' 0687-SO-070 GS-88-02 000746-0002	SP5/5A-18 15'-16.5' 0687-SO-070 GS-88-03 000746-0003	SP5/5A-19 5'-6.5' 0687-SO-071 GS-88-01 000746-0004	SP5/5A-19 10'-11.5' 0687-SO-071 GS-88-02 000746-0005	SP5/5A-19 15'-16.5' 0687-SO-071 GS-88-03 000746-0018	SP5/5A-19 0687-NG-071 GN-88-0004 001121-0004
Benzene	EPA 602	ug/L	5.0						270.
Ethanol	Method 8240	mg/kg					0.26		
Ethyl benzene	EPA 602	ug/L	700						690.
Methylene chloride	Method 8240	mg/kg							
Toluene	Method 8240	mg/kg	15,000						
Total Dissolved Solids	160.1	mg/L	500						
Total Petroleum Hydrocarbons	3550/418.1 Mod.								
Total Solids	160.3	%		85.5	81.4	93.3	91.4	90.3	
Total xylenes	Method 8240	mg/kg	500						
m-Xylene	EPA 602	ug/L	440						530.
o & p-Xylene(s)	EPA 602	ug/L	440						990.

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	TRIP BLANK	SP5/5A-06 5'-6.5' 0687-SO-077 GS-88-01 000706-0004	SP5/5A-06 25'-26.5' 0687-SO-077 GS-88-02 000706-0005	SP5/5A-06 40'-41.5' 0687-SO-077 GS-88-03 000706-0006	SP5/5A-07 48'-49.5' 0687-SO-078 GS-88-01 000700-0012	SP5/5A-07 55'-56.5' 0687-SO-078 GS-88-02 000700-0013
ALKALINITY (as CaCO3)	310.2	mg/L							
BARIUM	200.7	mg/L	1.0						
BICARBONATE	310.2	mg/L							
BORON	200.7	mg/L		0.066					
BROMIDE	A429	mg/L							
Benzene	EPA 602	ug/L	5.0						
CALCIUM	200.7	mg/L		0.014					
CHLORIDE	A429	mg/L	250						
CHROMIUM	200.7	mg/L	0.05	0.01					
Ethyl benzene	Method 8240	mg/kg	5,000						
FLUORIDE	A429	mg/L	2.0						
MAGNESIUM	200.7	mg/L							
MANGANESE	200.7	mg/L	0.05						
MOISTURE	GRAV.	%							
MOLYBDENUM	200.7	mg/L							
NICKEL	200.7	mg/L							
NITRATE & NITRITE (as N)	353.2	mg/L	10						
OIL & GREASE	413.2	mg/L							
SULFATE	A429	mg/L	250						
TOC	415.1	mg/L							
TOT PHOSPHATE	365.4	mg/L							
Toluene	EPA 602	ug/L	2,000						
Total Dissolved Solids	160.1	mg/L	500	11					
Total Solids	160.3	%			92.5	89.9	88.9	84.6	87.9
Total xylenes	Method 8240	mg/kg	500						
m-Xylene	EPA 602	ug/L	440						
o & p-Xylene(s)	EPA 602	ug/L	440						

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP5/5A-07 0687-NG-078-GN-88-0003 001121-0005	SP5/5A-03 5'-6.5' 0687-SO-074 GS-88-01 000700-0001	SP5/5A-03 30'-31.5' 0687-SO-074 GS-88-02 000700-0002	SP5/5A-01 40'-41.5' 0687-SO-072 GS-88-01 000706-0007	SP5/5A-01 45'-46.5' 0687-SO-072 GS-88-02 000706-0008	SP5/5A-01 0687-NG-072 GN-88-0003 001115-0001
ALKALINITY (as CaCO3)	310.2	mg/L							
BARIUM	200.7	mg/L	1.0						
BICARBONATE	310.2	mg/L							
BORON	200.7	mg/L							
BROMIDE	A429	mg/L							
Benzene	EPA 602	ug/L	5.0	4200.					4.4
CALCIUM	200.7	mg/L							
CHLORIDE	A429	mg/L	250						
CHROMIUM	200.7	mg/L	0.05						
Ethyl benzene	Method 8240	mg/kg	5,000	1000.					75
FLUORIDE	A429	mg/L	2.0						
MAGNESIUM	200.7	mg/L							
MANGANESE	200.7	mg/L	0.05						
MOISTURE	GRAV.	%							
MOLYBDENUM	200.7	mg/L							
NICKEL	200.7	mg/L							
NITRATE & NITRITE (as N)	353.2	mg/L	10						
OIL & GREASE	413.2	mg/L							
SULFATE	A429	mg/L	250						
TOC	415.1	mg/L							
TOT PHOSPHATE	365.4	mg/L							
Toluene	EPA 602	ug/L	2,000	3500.					32
Total Dissolved Solids	160.1	mg/L	500						
Total Solids	160.3	%			91.2	85.8	85.0	85.2	
Total xylenes	Method 8240	mg/kg	500						
m-Xylene	EPA 602	ug/L	440	1200.					
o & p-Xylene(s)	EPA 602	ug/L	440	1800.					170

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP5/5A-09 40'-41.5' 0687-SO-080 GS-88-02 000700-0004	SP5/5A-09 30'-33' 0687-SO-080 GS-88-01 000700-0003	SP5/5A-02 0687-NG-073-0004 000837-0005	SP5/5A-02 10'-11.5' 0687-SO-073 GS-88-01 000706-0010	SP5/5A-02 35'-36.5' 0687-SO-073 GS-88-02 000706-0011	SP5/5A-02 35'-36.5' 0687-SO-073 GS-88-03 000706-0012
ALKALINITY (as CaCO3)	310.2	mg/L							
BARIUM	200.7	mg/L	1.0						
BICARBONATE	310.2	mg/L							
BORON	200.7	mg/L							
BROMIDE	A429	mg/L							
Benzene	EPA 602	ug/L	5.0						
CALCIUM	200.7	mg/L							
CHLORIDE	A429	mg/L	250						
CHROMIUM	200.7	mg/L	0.05						
Ethyl benzene	Method 8240	mg/kg	5,000						
FLUORIDE	A429	mg/L	2.0						
MAGNESIUM	200.7	mg/L							
MANGANESE	200.7	mg/L	0.05						
MOISTURE	GRAV.	%							
MOLYBDENUM	200.7	mg/L							
NICKEL	200.7	mg/L							
NITRATE & NITRITE (as N)	353.2	mg/L	10						
OIL & GREASE	413.2	mg/L							
SULFATE	A429	mg/L	250						
TOC	415.1	mg/L							
TOT PHOSPHATE	365.4	mg/L							
Toluene	EPA 602	ug/L	2,000						
Total Dissolved Solids	160.1	mg/L	500			785			
Total Solids	160.3	%		87.2	91.6		91.2	86.2	92.0
Total xylenes	Method 8240	mg/kg	500						
m-Xylene	EPA 602	ug/L	440						
o & p-Xylene(s)	EPA 602	ug/L	440						

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP5/5A-04 45'-46.5' 0687-SO-075 GS-88-01 000700-0016	SP5/5A-04 60'-61.5' 0687-SO-075 GS-88-02 000700-0017	SP5/5A-05 5'-6.5' 0687-SO-076 GS-88-01 000700-0009	SP5/5A-05 50'-51.5' 0687-SO-076 GS-88-02 000700-0010	SP5/5A-08 10'-11.5' 0687-SO-079 GS-88-01 000700-0005	SP5/5A-08 20'-21.5' 0687-SO-079 GS-88-02 000700-0006
ALKALINITY (as CaCO3)	310.2	mg/L							
BARIUM	200.7	mg/L	1.0						
BICARBONATE	310.2	mg/L							
BORON	200.7	mg/L							
BROMIDE	A429	mg/L							
Benzene	EPA 602	ug/L	5.0						
CALCIUM	200.7	mg/L							
CHLORIDE	A429	mg/L	250						
CHROMIUM	200.7	mg/L	0.05						
Ethyl benzene	Method 8240	mg/kg	5,000						
FLUORIDE	A429	mg/L	2.0						
MAGNESIUM	200.7	mg/L							
MANGANESE	200.7	mg/L	0.05						
MOISTURE	GRAV.	%							
MOLYBDENUM	200.7	mg/L							
NICKEL	200.7	mg/L							
NITRATE & NITRITE (as N)	353.2	mg/L	10						
OIL & GREASE	413.2	mg/L							
SULFATE	A429	mg/L	250						
TOC	415.1	mg/L							
TOT PHOSPHATE	365.4	mg/L							
Toluene	EPA 602	ug/L	2,000						
Total Dissolved Solids	160.1	mg/L	500						
Total Solids	160.3	%		88.6	85.1	98.0	87.6	84.4	82.5
Total xylenes	Method 8240	mg/kg	500						
m-Xylene	EPA 602	ug/L	440						
o & p-Xylene(s)	EPA 602	ug/L	440						

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP5/5A-10 0687-NG-081 GN-88-0003 001121-0001	SP5/5A-10 1.5'-3' 0687-SO-081 GS-88-0001 000805-0003	SP5/5A-10 5'-6.5' 0687-SO-081 GS-88-0002 000805-0004	SP5/5A-20 5'-6.5' 0687-SO-126,GS-88-0002 001370-0003	SP5/5A-20 0'-1.5' 0687-SO-126,GS-88-0001 001370-0002	SP5/5A-11 1'-1.5' 0687-SO-082 GS-88-01 000706-0013
ALKALINITY (as CaCO3)	310.2	mg/L							
BARIUM	200.7	mg/L	1.0						
BICARBONATE	310.2	mg/L							
BORON	200.7	mg/L							
BROMIDE	A429	mg/L							
Benzene	EPA 602	ug/L	5.0	28.					
CALCIUM	200.7	mg/L							
CHLORIDE	A429	mg/L	250						
CHROMIUM	200.7	mg/L	0.05						
Ethyl benzene	Method 8240	mg/kg	5,000	12.		2.8			
FLUORIDE	A429	mg/L	2.0						
MAGNESIUM	200.7	mg/L							
MANGANESE	200.7	mg/L	0.05						
MOISTURE	GRAV.	%							
MOLYBDENUM	200.7	mg/L							
NICKEL	200.7	mg/L							
NITRATE & NITRITE (as N)	353.2	mg/L	10						
OIL & GREASE	413.2	mg/L							
SULFATE	A429	mg/L	250						
TOC	415.1	mg/L							
TOT PHOSPHATE	365.4	mg/L							
Toluene	EPA 602	ug/L	2,000						
Total Dissolved Solids	160.1	mg/L	500						
Total Solids	160.3	%			85.7	84.7	17.9	28.8	93.0
Total xylenes	Method 8240	mg/kg	500			19			
m-Xylene	EPA 602	ug/L	440	10.					
o & p-Xylene(s)	EPA 602	ug/L	440	18.					

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SP5/5A-11 4'-4.5' 0687-SO-082 GS-88-02 000706-0001	SP5/5A-11 4'-4.5' DUPLICATE 0687-SO-082 GS-88-02 000706-0001	SP5/5A-12 .5'-1.0' 0687-SO-083 GS-88-01 000706-0002	SP5/5A-12 4.5'-5.0' 0687-SO-083 GS-88-02 000706-0003	W-7 GN840277	W-8 GN840278
ALKALINITY (as CaCO3)	310.2	mg/L							
BARIUM	200.7	mg/L	1.0						
BICARBONATE	310.2	mg/L							
BORON	200.7	mg/L							
BROMIDE	A429	mg/L							
Benzene	EPA 602	ug/L	5.0						
CALCIUM	200.7	mg/L							
CHLORIDE	A429	mg/L	250						
CHROMIUM	200.7	mg/L	0.05						
Ethyl benzene	Method 8240	mg/kg	5,000						
FLUORIDE	A429	mg/L	2.0						
MAGNESIUM	200.7	mg/L							
MANGANESE	200.7	mg/L	0.05						
MOISTURE	GRAV.	%							
MOLYBDENUM	200.7	mg/L							
NICKEL	200.7	mg/L							
NITRATE & NITRITE (as N)	353.2	mg/L	10						
OIL & GREASE	413.2	mg/L							3
SULFATE	A429	mg/L	250						
TOC	415.1	mg/L						4	2
TOT PHOSPHATE	365.4	mg/L							
Toluene	EPA 602	ug/L	2,000						
Total Dissolved Solids	160.1	mg/L	500						
Total Solids	160.3	%		93.6	92.3	91.1	87.9		
Total xylenes	Method 8240	mg/kg	500						
m-Xylene	EPA 602	ug/L	440						
o & p-Xylene(s)	EPA 602	ug/L	440						

Table 4.2.20.4

Analytical Results - Site SP-5/5A

Parameter	Method	Units	Standards, Criteria and Action Levels	W-7 5'	W-7	W-7	W-8	W-8	W-8
			Federal/State	W-7-2	W-7/23	W-7/28	W-8-2	W-8/24	W-8/27
ALKALINITY (as CaCO3)	310.2	mg/L				350			290
BARIUM	200.7	mg/L	1.0			0.12			0.056
BICARBONATE	310.2	mg/L				350			290
BORON	200.7	mg/L							
BROMIDE	A429	mg/L				0.7			0.3
Benzene	EPA 602	ug/L	5.0						
CALCIUM	200.7	mg/L				120			80
CHLORIDE	A429	mg/L	250			120			47
CHROMIUM	200.7	mg/L	0.05			0.013			0.011
Ethyl benzene	Method 8240	mg/kg	5,000						
FLUORIDE	A429	mg/L	2.0			0.1			0.2
MAGNESIUM	200.7	mg/L				38			22
MANGANESE	200.7	mg/L	0.05			0.21			0.005
MOISTURE	GRAV.	%		12			16		
MOLYBDENUM	200.7	mg/L				0.048			
NICKEL	200.7	mg/L							0.02
NITRATE & NITRITE (as N)	353.2	mg/L	10			4.9			1.1
OIL & GREASE	413.2	mg/L		36					0.05
SULFATE	A429	mg/L	250			20			
TOC	415.1	mg/L							
TOT PHOSPHATE	365.4	mg/L				1			
Toluene	EPA 602	ug/L	2,000						2
Total Dissolved Solids	160.1	mg/L	500		460			390	10
Total Solids	160.3	%							
Total xylenes	Method 8240	mg/kg	500						
m-Xylene	EPA 602	ug/L	440						
o & p-Xylene(s)	EPA 602	ug/L	440						

Total petroleum hydrocarbons were observed in the soil samples at only 2 locations, well SP5/5A-16 and boring SP5/5A-17. Concentration levels ranged from 67 mg/kg at boring SP5/5A-17 to 290 mg/kg at well SP5/5A-16.

4.2.20.2 Sampling or Analytical Problems

The following sections discuss problems relating to the loss of samples or problems with sample or analytical contamination. In addition, any deviations from the workplan and the corrective actions taken are discussed.

4.2.20.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis from Site SP-5/5A were lost.

4.2.20.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is possible that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures were strictly followed during both soil and water sampling episodes. However, several compounds not usually associated with fuels, but present in the laboratory environment were detected in samples collected from Site SP-5/5A. These are: methylene chloride (a common laboratory solvent) and ethanol (a laboratory reagent/solvent). It is possible that these compounds, detected at low concentrations, were present as cross-contaminants or carry-over contamination from other samples/sites that the laboratory was analyzing. However, review of QA/QC data does not allow methylene chloride or ethanol to be considered as a laboratory contaminants at this site.

4.2.20.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Seven wells were to be installed at Site SP-5A. However, the advancement of borings at 2 of the predetermined well locations (SP5/5A-14 and SP5/5A-17) did not encounter water. This can be identified as an out-of-control condition. The borings were completed to depths of 25 and 28 feet, respectively, and soil samples were collected from the test holes during drilling. Since it was impossible to collect water samples at these 2 locations, deviation from the SOW occurred. The USAFOEHL/TS Technical Program Manager was informed of the situation and agreed to backfilling the boreholes with volclay slurry.

A subsequent deviation from the SOW occurred when, at the request of USAFOEHL/TS Technical Program Manager personnel, an additional well (SP5/5A-20) was installed at Site SP-5. Well SP5/5A-20 was added in lieu of the proposed well at Site FT-1 after that site was deleted from the scope of work by the Technical Program Manager. Soil samples we _ collected during drilling of the well, and water samples were obtained after well installation and development.

4.1.20.2.4 Corrective Actions Applied to Out-of-Control Events

The USAFOEHL/TS Technical Program Manager was informed of all out-of-control events at Site SP-5/5A; he suggested and/or agreed to the corrective actions as described above.

4.1.20.3 Significance of Findings

Site SP-5/5A is contaminated with fuel and with the soluble components of fuel, primarily the compounds benzene, toluene, ethylbenzene and

the various xylenes. These compounds were detected in both soil and water samples as indicated in Table 4.2.20.4. Current standards for groundwater contamination are exceeded at the site: benzene exceeded its MCL of 5 ug/L, toluene, ethylbenzene, and total xylenes exceeded the proposed state MCLs of 2,000, 700, and 440 mg/L respectively. Site specific parameters for soil contamination by fuels are not currently legislated or part of the Alaska Administrative Code (AAC).

Methylene chloride and ethanol were also detected in soil samples at site SP-5/5A. Methylene chloride is a listed hazardous waste under RCRA. The possible sources for these compounds include use onsite as a solvent and antifreeze agents (ethanol). Both are common laboratory contaminants. However, review of QA/QC data does not allow methlyene chloride or ethanol to be written off as laboratory contaminants in this case. Soil standards for these compounds do not currently exist.

Pathways of exposure to these compounds include groundwater, surface water, ingestion of affected plants and inhalation of vapors.

Basic receptors are humans, wildlife and plants, primarily at the seep location, and from surface water in the ditch below the seep.

Contamination was detected in the field at several locations where laboratory analysis did not detect total petroleum hydrocarbons (TPH) or volatile aromatics. Methods of field detection included HNu readings, odors and soil gas readings.

4.2.20.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. Soil gas data indicated that some contamination exists in the northwest area of the site. This is

supported by the results at well SP5/5A-10. Soil gas data also indicates contamination in several areas in the southern half of the site. Data from test borings and monitoring wells confirms the presence of contaminants. General concentration lines have been constructed for the soil gas data. There is insufficient data from other sources for three-dimensional, temporal or higher definition spatial mapping.

4.2.20.3.2 Contaminant Migration

The potential migration media at Site SP-5/5A are surface water, groundwater and soils. Contaminants in the pure product phase (nonaqueous liquid phase) can move through the soils either in layers of increased conductivity for the product, or on the top of the saturated zone. Contaminants can also move as dissolved components in the groundwater and surface waters.

The product is migrating in the subsurface, as evidenced by the presence of a sheen of product at the seep location. The combination of soil gas data and the water well data indicate that there is a potential for groundwater migration of soluble components, but there is no firm link between the groundwater gradient and the contaminant concentrations at this time. Data from this study is insufficient to determine the quantity of product that may be present. The areas that are affected by the contamination are the southern portion of the site near Loop road, the central area near well SP5/5A-01, and the northwest area, well SP5/5A-10. Vertical distribution appears to be primarily at or near the water table, or as dissolved contaminants in the groundwater.

4.2.20.3.2.1 Potential for Offsite and Off-Base Migration

Offsite migration of product is occurring at the seep location near SP5/5A-16. Some offsite migration of dissolved contaminants is

occurring in the surface water of the ditch below the seep. This study cannot determine if offsite migration of contaminated groundwater is occurring, due to lack of analytical data from downgradient wells. Downgradient wells were not installed because they were not included in the scope of work. The concentrations in the groundwater at well SP5/5A-16 and well SP5/5A-10 indicate that the potential for offsite migration by contaminated groundwater exists.

4.2.20.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site provides for 2 major directions of contaminant flow, based on the identification of a hydrogelogic divide in the central portion of the site. These directions are to the southeast and the northwest. The hydraulic conductivities at the site (the rates of migration of groundwater) were variable, and ranged from 0.053 feet per day to too fast to measure by the techniques used. The rate of migration of the contaminants in the groundwater will depend upon the point of release to the groundwater and the concentration of materials at that point. The factors controlling the migration of nonaqueous phase liquids are poorly understood. This study cannot make an estimate of the rate of migration of the product.

4.2.20.3.2.3 Time of Travel to Receptors

Primary receptors are humans, plants and wildlife. The primary pathway is through contaminated surface water, groundwater and vapors at the seep. With the active seep, onsite plants are exposed to the contaminants and other receptors could be exposed to the contaminants any time they come onsite.

4.1.20.3.2.4 Applicability of Solute Transport Models

The applicability of solute transport models at site SP-5/5A cannot be determined by this study, because installation of downgradient wells to the northwest and sampling of 2 downgradient wells to the southwest, which were previously installed by Dames & Moore, were not included in the Scope of Work. The potential for useful data and accurate solute transport models exists, provided better hydrogeological data is available and downgradient wells are installed and sampled. The results from solute transport modeling would help determine the potential risk of contamination for downgradient water supplies.

4.2.20.3.2.5 Expected Spatial and Temporal Variations in Concentrations

Two primary groundwater flow directions exist, to the southeast and to the northwest. The concentrations of contaminants indicated by the soil gas survey in the area of Tank 604 were not directly confirmed by soil sampling. This contamination may be affecting the contamination detected at well SP5/5A-19, as it is downgradient from Tank 604.

Contamination to the southeast may extend for a distance, due to the concentrations of solutes detected at well SP5/5A-16. Contamination to the northwest may not extend for any great distance due to concentrations detected at well SP5/5A-10. The spread of contamination perpendicular to groundwater flow is expected due to mechanical dispersion and chemical diffusion, but cannot be estimated in the scope of this study. The variations in the locations of possible undetected contamination concentrations may also affect the spatial distribution of the contaminant concentrations.

Temporal variations may exist due to seasonal changes in the subsurface, such as frost, flow rates, and precipitation. If an amount of pure product is present, concentration may increase over time. Observable decreases in concentration with time will be considerably slower if pure product is present on or in the water table.

4.2.20.3.3 Baseline Risk Assessment

4.2.20.3.3.1 Waste Characterization

The primary waste at the site is the fuel product JP-4. As the tanks have been in place since the 1940's, other products have probably been stored in the tanks (JP-4 is a relatively new refined product). These other products may have included JP-5, diesel, and aviation and regular gasolines. These refined products all have some compounds in common. The compounds of interest are benzene, toluene, ethylbenzene and xylenes, commonly referred to as BETX. These are the more soluble and toxic components of fuels.

Fuels are less dense than water, have relatively low solubilities in water as a whole, are flammable, act as solvents for many organic compounds, can be explosive under certain conditions, and have variable toxicities and volatilities. Fuels are biodegradable at varying rates, depending on the environment. JP-4 contains higher amounts of BETX than some fuels. This is of concern because of the solubility and toxicity of these compounds. Benzene, the most toxic of the BETX compounds, is a known carcinogen.

Methylene chloride was detected at the site in soils. Methylene chloride is a common solvent and degreaser. It is narcotic in high concentrations and is a suspected carcinogen.

Ethanol, also known as ethyl alcohol, is the common "drinking" form of alcohol. It is a strong central nervous system depressant, and is toxic to fatal in large doses.

4.2.20.3.3.2 Source and Release Characterization

The source of the contaminants other than fuels at the site is undetermined. The release of fuels and the contamination of the groundwater by fuel related solutes could have occurred from periodic surface and subsurface spills, or chronic leaks in pipes, pits, valves and tanks.

The scope of this study cannot estimate the volume released, other than to refer back to the site background for spill estimates and to state that product was detected at the lower test pit.

4.2.20.3.3.3 Fate and Transport of Contaminants

Once the product has been released to the subsurface environment, it percolates downward to the water table as a nonaqueous phase liquid, or, if the release is small, stays in the soils as an adsorbed and absorbed product. With product actually in contact with the saturated zone, the primary release mechanism to the groundwater is through diffusion of solutes into the water. Some water becomes contaminated by solute diffusion in the unsaturated zone as it percolates down to the water table, and this is the primary mechanism of long term release to the groundwater where the soils have adsorbed and absorbed the entire release. Mechanical dispersion and chemical diffusion then distributes the solutes into the plume.

Some migration of the product phase contaminants is occurring, as evidenced by the seep near Loop Road. The transport rates, and the

plume dimensions and precise directions of groundwater contamination migration are not know for this site. Receptors are already exposed to the southeast, where contaminated water and product are seeping into the ditch along Loop Road. There is insufficient data to estimate the rate of flow for other areas of the site.

The fate of the contamination is unclear, especially as it concerns the contaminated groundwater flowing to the southeast. The visual impact of the seep flow is a noticeable die-off of vegetation in the ditch, along the ditch margins, and in the field that is the westernmost section of the runway area. The ditch crosses Loop Road about 200 meters east of the seep and disperses its flow into this field. The affected area extends for about 100 meters into the field. The product and contaminated water is probably undergoing volatilization and biologic breakdown in the ditch and field. There is a significant algal population in the flowing ditch. The 17 March 1986 Dames and Moore IRP Phase II Stage 1 report identified a TPH concentration in the soil at location W 7 of 36 mg/kg. W-7 is directly across the road from the seep.

4.2.20.3.3.4 Exposure Pathways

The primary pathways at the site are direct contact with contaminated water in the seep area, inhalation of vapors in the seep area or from monitoring wells during sampling, and ingestion of contamination groundwater or plants.

4.2.20.3.3.5 Identification of Receptors

Human receptors include casual exposure while driving on the road, direct contact with waters from the seep, either in the ditch or in

the field southeast (downgradient) from the ditch, offsite migration of BTEX contaminants into a water supply and subsequent ingestion, and secondary exposure through ingestion of berries or other plants from the site or the field to the southeast.

Wildlife could be exposed through the ingestion of contaminated water or vegetation. Possible secondary human exposure could occur if the wildlife is harvested as part of hunting activities allowed on-Base. Hunting in the immediate and nearby area of the site is not allowed.

4.2.20.3.3.6 Threat to Human Health

The most significant threat to human health is through potential exposure to the contaminated surface water in the area of the seep and the offsite migration of BETX contaminated groundwater, with the subsequent contamination of a drinking water supply.

4.2.20.3.3.7 Carcinogenic Risks

Benzene is a contaminant at the site. It has been detected in ground water samples at maximum concentrations of 21,000 ug/L. The allowable maximum concentration is 5 ug/L. Benzene is a known human carcinogen (Table 4.1.8).

Methylene chloride was detected at the site. The compound was detected at a maximum concentration of 5.5 mg/kg in soils. No contamination of groundwater was detected for this compound. The risk of exposure to methylene chloride is assessed as low. Methylene chloride is a suspected human carcinogen.

4.2.20.3.3.8 Threat to Wildlife

The primary area at which the wildlife of the area can easily be exposed to high concentrations of contaminants is at the southeast

seep area. This seep is on a road that has considerable traffic, and the seep drains into a field that is directly in line with the major runway. The combination of traffic and noise effectively minimizes the wildlife population. The threat to wildlife at the site is assessed as low.

4.2.20.4 Prioritization of Site SP-5/5A for Remedial Alternatives

Site SP-5/5A is assigned a high priority for development of preliminary remedial actions, due to the benzene concentration in groundwater, the exposure to product at the seep, the presence of product in the subsurface, and the possibility of chronic releases from facilities currently in use.

Further investigation should focus on assessment of active facilities for chronic leaks (for example, inspection of WWII vintage tanks with concrete-rebar construction for leaks).

To assess the contaminant plume in the area southeast of the existing site, a soil gas survey should be conducted in the area. Also, 3 new monitoring wells should be installed in the southeast area. Within the current site boundary, 7 new monitoring wells should be installed. Some of these wells should be screened in the deeper region of the aquifer to assess the vertical extent of contamination. Existing wells W-7 and W-8 should also be sampled as part of any further investigation.

4.2.21 Results for Site NS-2, DRMO Scrap Pile

Drums containing various kinds of materials are stored in the vicinity of Site NS-2 (Figure 4.2.21.1) and some surface staining of the soil has resulted.

4.2.21.1 Presentation of REsults at Site NS-2

Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on site maps.

4.2.21.1.1 Site Geology

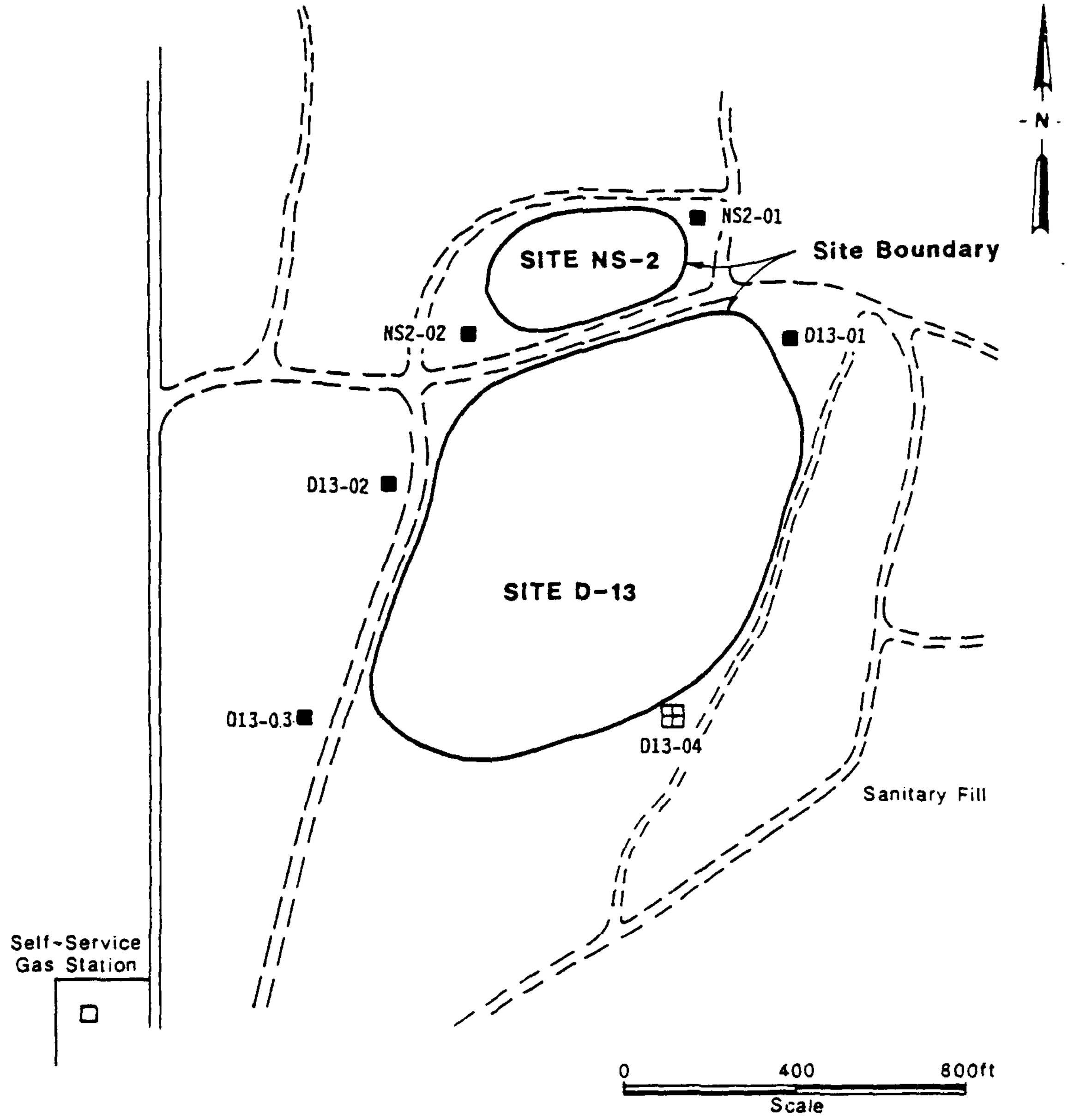
Site NS-2 is located at an elevation of 210 feet on flat terrain and is underlain by late-Quaternary glacial outwash deposits consisting chiefly of coarse sands and gravels with some silt. The outwash deposits are assumed to overlie silt and clay units of the Bootlegger Cove Formation at a depth exceeding 60 feet. The site has a moderately dense cover of cottonwood trees to 25 feet in height. The ground surface has the appearance of being regraded in the past. Some mostly metallic trash had been dumped on the site.

4.2.21.1.1.1 Borings

Two borings drilled at Site NS-2 were completed as monitoring wells. The borings encountered mostly sandy gravel with some silt in various sorted layers. Logs of the borings are included in Appendix C. A schematic geologic cross section of the site is provided in Figure 4.2.21.2.

4.2.21.1.2 Site Hydrogeology

Site NS-2 is underlain by sands and gravels with a water table depth of approximately 38 feet. The direction of groundwater flow is based



Legend:

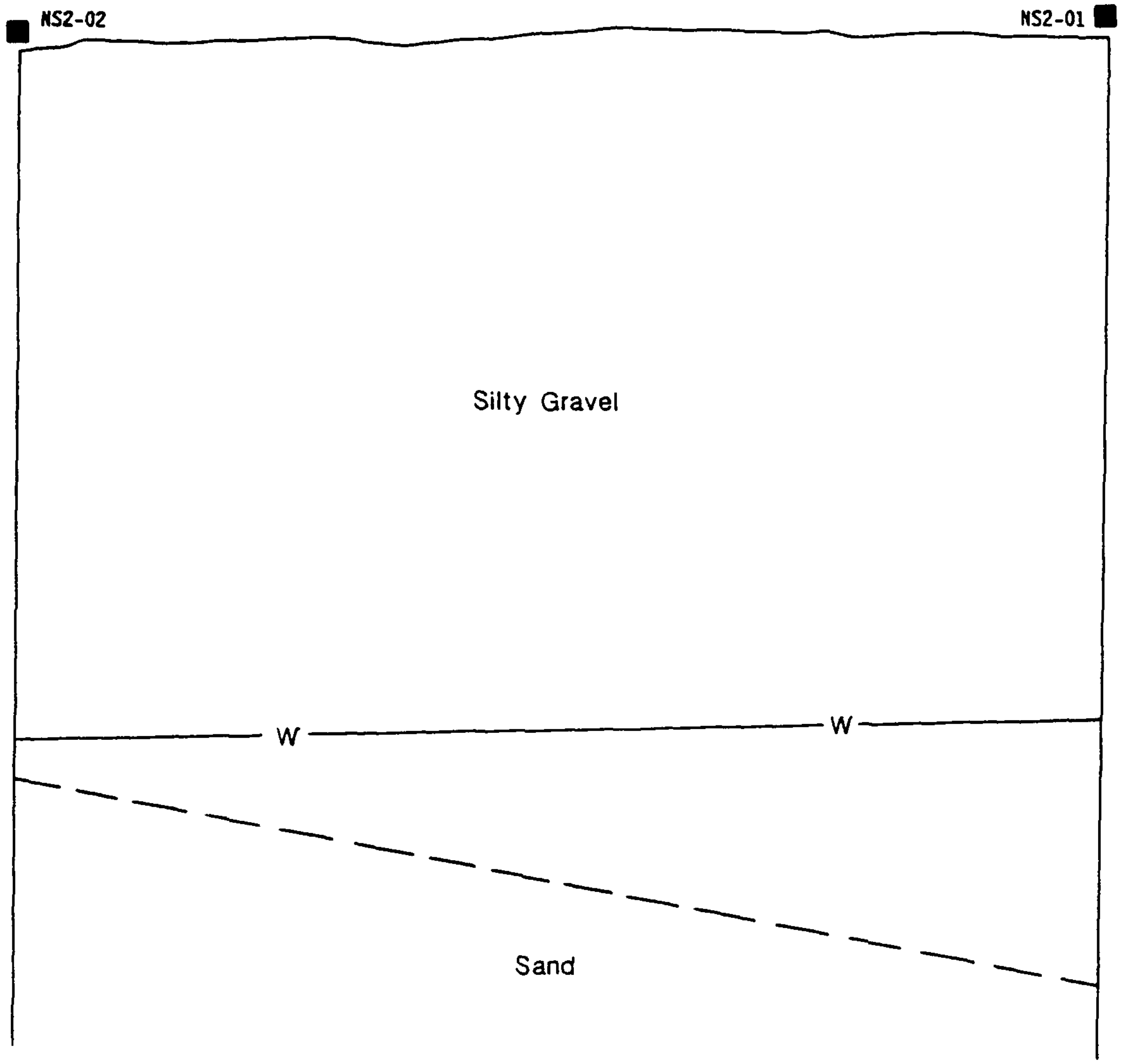
NS2-01 ■ Monitoring Well Location
Stage 3

D13-04 ⊞ Stage 3 Borehole

LOCATION MAP
SITE NS-2

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.21.1



Legend:

NS2-01 ■ Monitoring Well Location Stage 3

—W— Projected Water Table

—— – – Geologic Contact, Dashed Where Inferred

0 10 20ft

VERTICAL SCALE

0 100 200ft

HORIZONTAL SCALE

Notes:

1. Horizontal scale: 1 inch = 100 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Geologic cross section shown on Figure 4.2.21.3

GEOLOGIC CROSS SECTION
SITE NS-2

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.21.2

on a comparison of regional trends and waterlevel measurements at 13 wells in the area (Figure 4.2.21.3). The direction of groundwater flow is west-northwest with a gradient of approximately 20 feet per mile. These sites are located less than 0.5 mile downgradient from Ship Creek, which loses water to the groundwater system in this area. Hydraulic conductivity values have not been established for this site.

4.2.21.1.3 Analytical Field Results and Observations

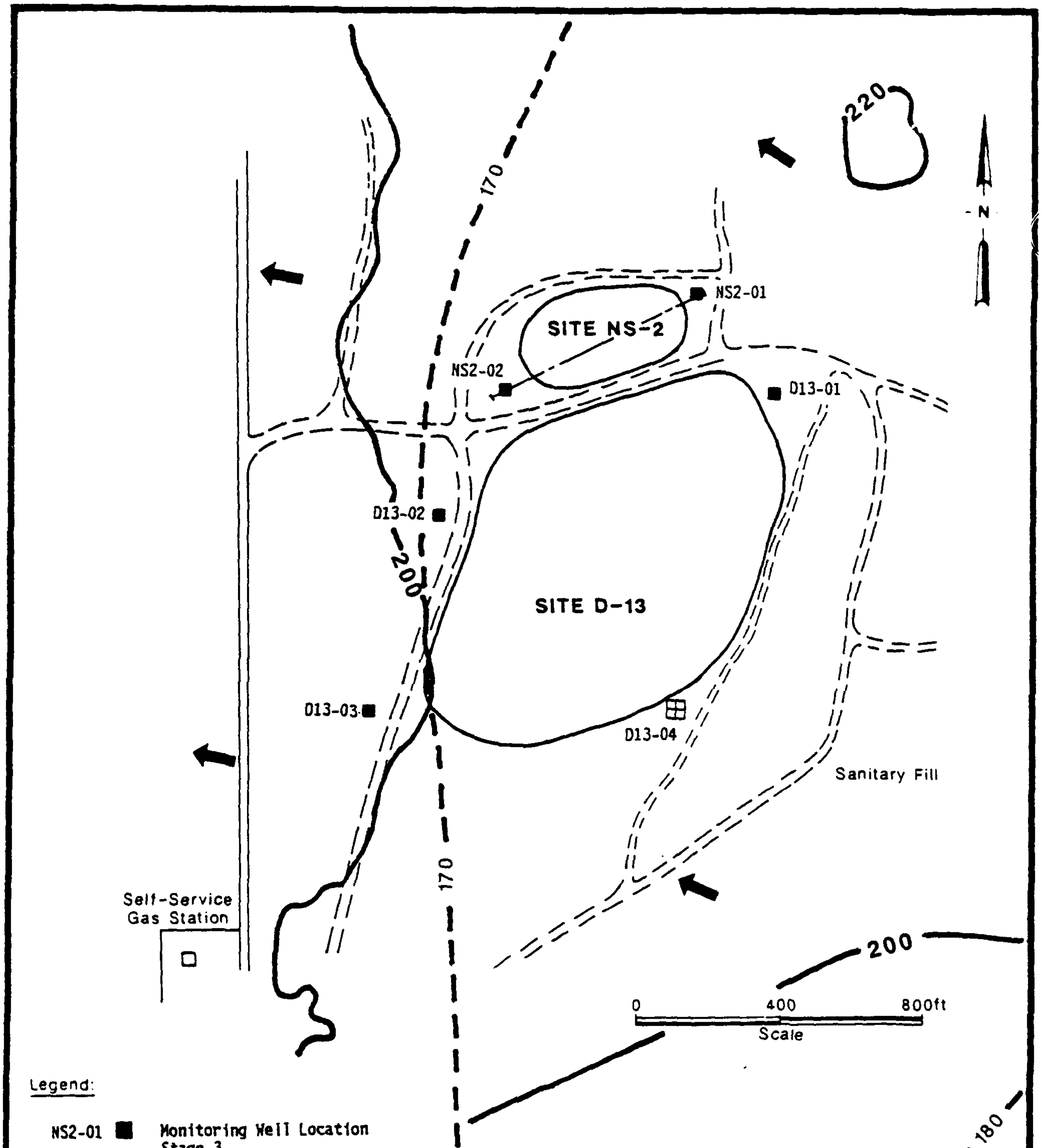
HNu readings of 5 ppm was recorded on a soil samples taken at a depths of 15 and 20 feet, respectively from NS2-02. Field parameters measured at Site NS-2 during groundwater sampling are presented on Table 4.2.21.1.

4.2.21.1.3.1 Laboratory Analytical Results

The laboratory analytical program for Site NS-2 is presented in Table 4.2.21.2, and the sample plan for the base-wide field investigation program is included in Appendix B. Major organic contaminants identified from the laboratory analysis of samples collected at Site NS-2 are plotted on Figures 4.2.21.4 and 4.2.21.5. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well or test boring. Sampling depth is included for the soil samples.

4.2.21.1.4 Analytical Results Table

Laboratory analytical results for detected parameters at Site NS-2 are presented on Table 4.2.21.3.

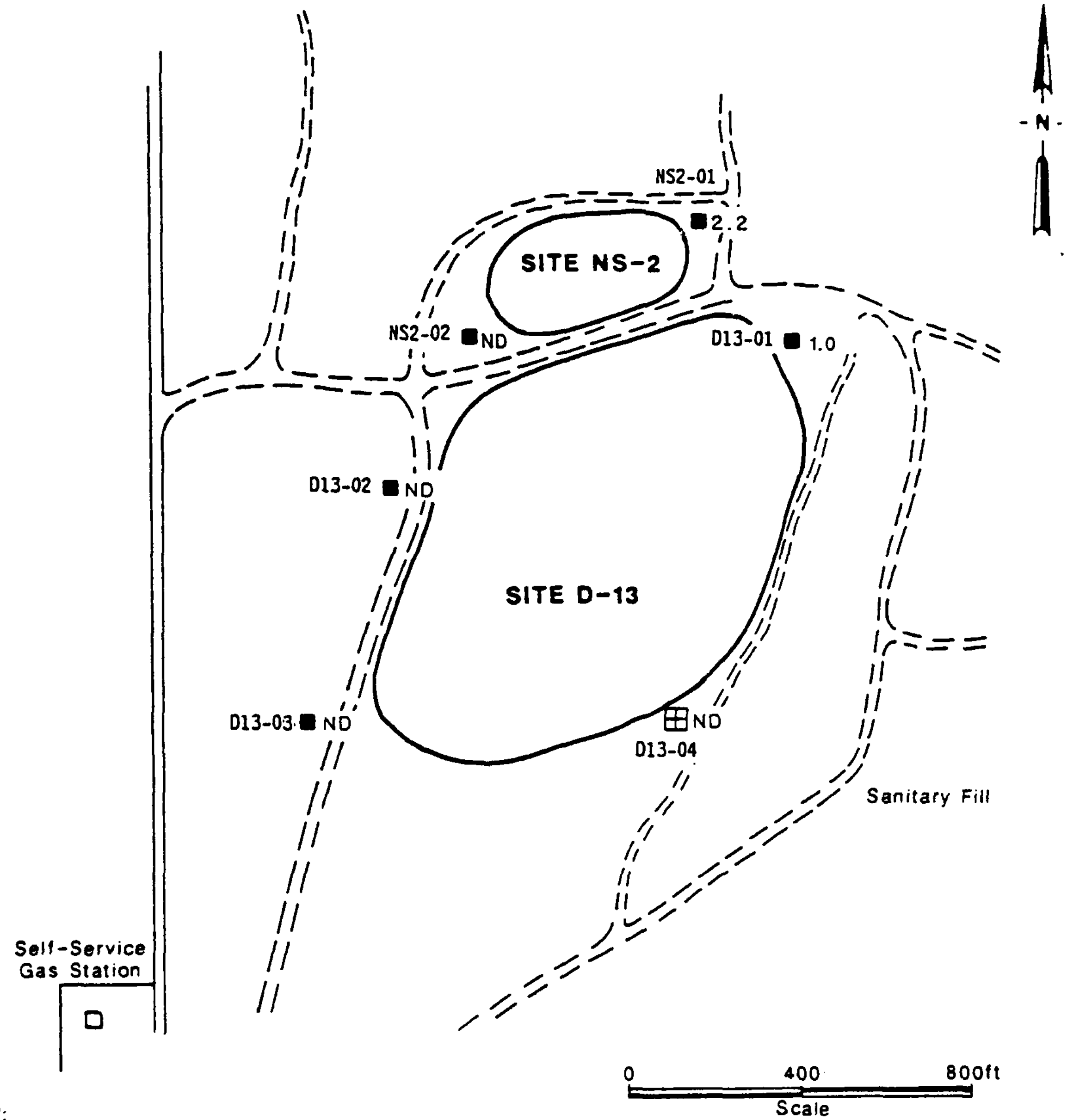


Legend:

- NS2-01 ■ Monitoring Well Location Stage 3
- D13-04 ⊞ Stage 3 Borehole
- ‒ ‒230‒ ‒ Water table contour. Contour intervals: 10ft.
- ➡ Approximate direction of groundwater flow.
- —300— Landsurface elevation contour. Contour intervals: 20ft.
- ├‒ ‒ ‒┤ Geologic Cross Section

HYDROGEOLOGIC MAP
SITE NS-2

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.21.3



Legend:

NS2-01 ■ Monitoring Well Location Stage 3

D13-04 ⊞ Stage 3 Borehole

- Well/Boring Number
- Well/Boring Location
- Depth of Sample (ft)
- Analyte Concentration

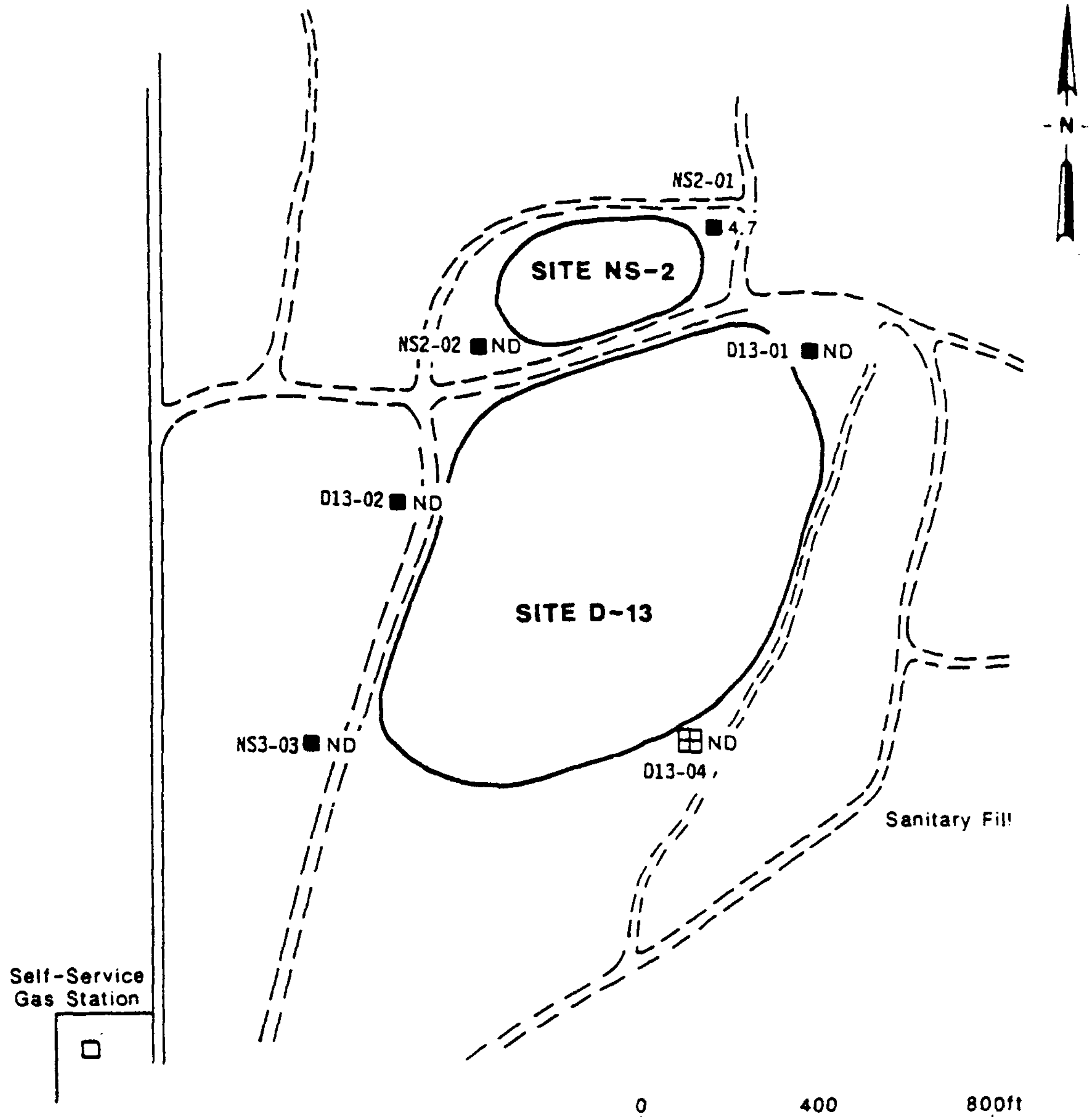
D13-04 (Symbol) 10/300 [Soil: mg/kg; Water: µg/L; ND Non-Detected]

Note: Water sample concentrations not associated with a depth.

VINYL CHLORIDE
CONCENTRATION
SITE NS-2

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.21.4



Legend:

D13-04 ⊞ Stage 3 Borehole

NS2-01 ■ Monitoring Well Location Stage 3

Boring/Well Number

Boring/Well Location

Depth of Sample (ft)

Analyte Concentration

D13-04 ⊞ 10/300

Soil: mg/kg
Water: µg/L
ND: Non-Detected

Note: Water sample concentrations not associated with a depth.

TRANS-1,2-DICHLOROETHENE CONCENTRATION SITES NS-2 and D-13

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.21.5

Table 4.2.21.1 Field Parameters Site NS-2

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
NS2-1	8/08/88	7.0	210	6.72	120	No odor or sheen
NS2-2	8/08/88	6.5	227	6.76	110	No odor or sheen

Table 4.2.21.2 Requested Analyses for Laboratory Samples at Site NS-2

SOIL

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
6010	ICP Screen
7471	Mercury
8080	Organochlorine Pesticides
8240	Volatile Organic Compounds
8270	Semi-volatile Organic Compounds
335.1	Cyanide
160.3	Soil Moisture Content

WATER

Test Number	Analysis
300	Common Anions
418.1	Petroleum Hydrocarbons
200.7	ICP Screen (total and dissolved)
206.2	Arsenic (total and dissolved)
239.2	Lead (total and dissolved)
245.1	Mercury (total dissolved)
270.2	Selenium (total and dissolved)
601	Purgeable Halocarbons
602	Purgeable Aromatics
625	Extractable Priority Pollutants

Table 4.2.21.3

Analytical Results - Site NS-2

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	NS2-01 RESAMPLE 0687-NG-106 GN-88-0002R 001229-0013	NS2-01 0687-NS-106 GN-88-0003 001167-0006	NS2-01 40'-41.5' 0687-SO-106 GS-88-0001 000797-0004	NS2-01 55'-56.5' 0687-SO-106 GS-88-0002 000797-0005	NS2-02 RESAMPLE 0687-NG-107 GN-88-0002R 001229-0012	NS2-02 0687-NS-107 GN-88-0003 001167-0001
Aluminum	6010	mg/kg				11678	11005		
Barium	6010	mg/kg				36	35		
Beryllium	6010	mg/kg				0.2	0.2		
Calcium	6010	mg/kg				4422	4306		
Chloride	300.0	mg/L	250						3.9
Chromium	6010	mg/kg	50,000			27	25		
Cobalt	6010	mg/kg				10	10		
Copper	6010	mg/kg	1,850			20	17		
Dissolved Aluminum	200.7	mg/L		0.35				6.4	
Dissolved Arsenic	206.2	mg/L	0.05	0.004	0.025			0.003	
Dissolved Barium	200.7	mg/L	1.0	0.043				0.081	
Dissolved Calcium	200.7	mg/L		41.				45.	
Dissolved Cobalt	200.7	mg/L						0.01	
Dissolved Copper	200.7	mg/L	1.0	0.013				0.056	
Dissolved Iron	200.7	mg/L	0.3	8.2				13.	
Dissolved Lead	239.2	mg/L	0.05	0.003	0.05			0.007	0.020
Dissolved Magnesium	200.7	mg/L		9.7				10.	
Dissolved Manganese	200.7	mg/L	0.05	5.7				2.3	
Dissolved Nickel	200.7	mg/L		0.01				0.03	
Dissolved Sodium	200.7	mg/L	250	21.				7.0	
Dissolved Vanadium	200.7	mg/L						0.02	
Dissolved Zinc	200.7	mg/L	5.0	0.04				0.04	
Iron	6010	mg/kg				25283	22010		
Magnesium	6010	mg/kg				9297	8971		
Manganese	6010	mg/kg	11,000			488	431		
Mercury	7471	mg/kg	100				0.07		
Nickel	6010	mg/kg				29	26		
Recoverable Aluminum	200.7	mg/L			76.				53.
Recoverable Arsenic	206.2	mg/L	0.05		0.008				0.010
Recoverable Barium	200.7	mg/L	1.0		0.79				0.56
Recoverable Beryllium	200.7	mg/L	0.0000039		0.003				
Recoverable Calcium	200.7	mg/L			69.				58.
Recoverable Chromium	200.7	mg/L	0.05		0.19				0.11
Recoverable Cobalt	200.7	mg/L			0.12				0.13
Recoverable Copper	200.7	mg/L	1.0		0.78				0.41
Recoverable Iron	200.7	mg/L	0.3		193.				116.
Recoverable Lead	239.2	mg/L	0.05		0.067				0.052
Recoverable Magnesium	200.7	mg/L			52.				32.
Recoverable Manganese	200.7	mg/L	0.05		11.				14.
Recoverable Nickel	200.7	mg/L			0.39				0.26
Recoverable Potassium	200.7	mg/L			5.				
Recoverable Sodium	200.7	mg/L	250		8.0				8.1
Recoverable Vanadium	200.7	mg/L			0.30				0.18
Recoverable Zinc	200.7	mg/L	5.0		0.51				0.28
Sodium	6010	mg/kg				113	120		
Sulfate	300.0	mg/L	250		13.				16.
Total Mercury	245.1	mg/L	0.002		0.005			0.0002	0.001
Total Solids	160.3	%			0.005	88.2	83.6		0.001
Vanadium	6010	mg/kg	1,000			44	41		
Vinyl chloride	EPA 601	ug/L	2		2.2				
Zinc	6010	mg/kg	10,500			49	44		
trans-1,2-Dichloroethene	EPA 601	ug/L	70		4.7				

Table 4.2.21.3

Analytical Results - Site NS-2

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	NS2-02 15'-16.5' 0687-SO-107 GS-88-0001 000797-0001	NS2-02 40'-41.5' 0687-SO-107 GS-88-0002 000797-0002
Aluminum	6010	mg/kg		12343	8916
Barium	6010	mg/kg		31	27
Beryllium	6010	mg/kg		0.3	0.1
Calcium	6010	mg/kg		5126	3837
Chloride	300.0	mg/L	250		
Chromium	6010	mg/kg	50,000	26	20
Cobalt	6010	mg/kg		10	7
Copper	6010	mg/kg	1,850	22	16
Dissolved Aluminum	200.7	mg/L			
Dissolved Arsenic	206.2	mg/L	0.05		
Dissolved Barium	200.7	mg/L	1.0		
Dissolved Calcium	200.7	mg/L			
Dissolved Cobalt	200.7	mg/L			
Dissolved Copper	200.7	mg/L	1.0		
Dissolved Iron	200.7	mg/L	0.3		
Dissolved Lead	239.2	mg/L	0.05		
Dissolved Magnesium	200.7	mg/L			
Dissolved Manganese	200.7	mg/L	0.05		
Dissolved Nickel	200.7	mg/L			
Dissolved Sodium	200.7	mg/L	250		
Dissolved Vanadium	200.7	mg/L			
Dissolved Zinc	200.7	mg/L	5.0		
Iron	6010	mg/kg		26360	18623
Magnesium	6010	mg/kg		8787	6885
Manganese	6010	mg/kg	11,000	575	451
Mercury	7471	mg/kg	100	0.05	0.07
Nickel	6010	mg/kg		26	21
Recoverable Aluminum	200.7	mg/L			
Recoverable Arsenic	206.2	mg/L	0.05		
Recoverable Barium	200.7	mg/L	1.0		
Recoverable Beryllium	200.7	mg/L	0.0000039		
Recoverable Calcium	200.7	mg/L			
Recoverable Chromium	200.7	mg/L	0.05		
Recoverable Cobalt	200.7	mg/L			
Recoverable Copper	200.7	mg/L	1.0		
Recoverable Iron	200.7	mg/L	0.3		
Recoverable Lead	239.2	mg/L	0.05		
Recoverable Magnesium	200.7	mg/L			
Recoverable Manganese	200.7	mg/L	0.05		
Recoverable Nickel	200.7	mg/L			
Recoverable Potassium	200.7	mg/L			
Recoverable Sodium	200.7	mg/L	250		
Recoverable Vanadium	200.7	mg/L			
Recoverable Zinc	200.7	mg/L	5.0		
Sodium	6010	mg/kg		94	79
Sulfate	300.0	mg/L	250		
Total Mercury	245.1	mg/L	0.002		
Total Solids	160.3	%		95.6	90.2
Vanadium	6010	mg/kg	1,000	47	28
Vinyl chloride	EPA 601	ug/L	2		
Zinc	6010	mg/kg	10,500	51	52
trans-1,2-Dichloroethene	EPA 601	ug/L	70		

4.2.21.1.5 Discussion of Analytical Data

Chlorinated hydrocarbon compounds were detected at Site NS-2. However, the concentrations were generally low and isolated to 2 compounds. For example, vinyl chloride (2.2 ug/L) and trans-1,2-dichloroethene (4.7 ug/L) were detected in water samples from well NS2-01.

Metals such as aluminum (8600 to 12300 mg/kg), iron (18600 to 26400 mg/kg), manganese (430 to 580 mg/kg) and magnesium (6800 to 9300 mg/kg) were detected in soil samples from the site. Total metals concentration in water samples were as high as 76 mg/L of aluminum, 193 mg/L of iron, 14 mg/L of manganese and 52 mg/L of magnesium, respectively. The values of these metals are related to the natural mineral content of the local soils, as described in Section 4.1.2.

Calcium levels were detected in soil samples (3400 to 4900 mg/kg) and water samples (total: 58 and 69 mg/L). Sodium levels were detected in soil samples (79 to 110 mg/kg) and water samples (total:8 and 8.1 mg/L). Total recoverable potassium was detected only in water from well NS2-01 (5 mg/L).

Sulfate ions were detected in water samples from both wells NS2-01 and NS2-02 at concentrations of 13 mg/L and 16 mg/L respectively and chloride ions were detected in a water sample from well NS2-01 at a concentration of 3.9 mg/L.

Small amounts (less than 50 mg/kg) of other elements such as barium, chromium, cobalt, copper, nickel, vanadium, and zinc were detected in soil samples from all borings. Water samples from wells NS2-01 and NS2-02 contained all of these elements at concentrations less than 0.08 mg/L.

Trace amounts of beryllium (less than 0.5 mg/kg) and mercury (less than 0.1 mg/kg) were detected in soil samples from both wells NS2-01 and NS2-02. A water sample from well NS2-01 contained beryllium (0.003 mg/L), total mercury (0.005 mg/L), and total recoverable arsenic (0.008 mg/L). Total mercury (0.001 mg/L), arsenic (0.01 mg/L) and lead (0.052 mg/L) were detected in a water sample from well NS2-02.

4.2.21.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site NS-2 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.21.2.1 Loss of Samples

No soil or water samples collected for laboratory anaylysis were lost from Site NS-02.

4.2.21.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results.

4.2.21.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Four soil samples were collected from 2 test borings at Site NS-2. The borings were completed as monitoring wells and 1 water sample was

obtained from each well. The water samples were to be tested for dissolved metals, but were not originally filtered in the field. This was corrected by resampling the 2 wells for only dissolved metals, and filtering the samples on site prior to shipment.

4.2.21.2.4 Corrective Actions Applied to Out-of-Control Events, Including a Chronology of Rerunning Samples and Controls

Water samples were retaken from both wells at Site NS-2 and tested for dissolved metals. The following table shows when sampling and resampling activities were conducted.

Well Number	Original Sampling Date	Resampling Date
NS2-01	8/8/88	8/13/88
NS2-02	8/8/88	8/13/88

4.2.21.3 Significance of Findings for Site NS-2

Analytical results for water samples from Site NS-2 indicated contamination by various organic compounds. Iron and manganese were detected at levels exceeding State of Alaska secondary standards but were similar background concentrations.

The source of the organic contamination in the groundwater is most likely shop wastes, buried drums containing unknown wastes, and steel and metal alloy debris buried in the landfills at Site D-13 and Site D-5. Basic receptors are humans, wildlife, and plants. Pathways of exposure to the receptors include ingestion of groundwater by humans and wildlife. Due to the depth of groundwater at the site (about 40 feet), uptake of contamination by plants is probably only important to species recolonizing the disturbed areas.

4.2.21.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. Well W-1 at Site D-5, sampled as part of the investigation for Site D-5 (Section 4.2.2.3) is the most upgradient well in the area of Site NS-2. The next well along the gradient, well NS2-01, was contaminated above the State of Alaska Primary Standard for vinyl chloride (2 ug/L). Due to the lack of clear definition of site boundaries, it is not readily apparent if wells NS2-01 and NS2-02 are outside of or within the landfills at Site D-13 and Site D-5.

4.2.21.3.2 Contaminant Migration

The primary migration medium at Site NS-2 is groundwater. A pattern of contamination migration along the groundwater gradient is not clearly evident from the data.

4.2.21.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off-Base migration at Site NS-2 is unknown. Historical records suggest that well NS2-02 may be outside and downgradient of the landfill boundary. However, surface trash and rubble was observed to the immediate west of well NS2-02, suggesting that the well is located on the fringes of the landfill. Well NS2-01 is most likely within the landfill boundaries and was contaminated with vinyl chloride above its MCL.

4.2.21.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site identified the direction of groundwater flow to be to the west-northwest, with a gradient of about 20 feet per mile. The rate of migration of the contaminants in the

groundwater will depend upon the point of release to the groundwater, the actual groundwater flow rate, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of migration rate of the dissolved chemicals.

4.2.21.3.2.3 Time of Travel to Receptors

Primary receptors are humans, plants, and wildlife. The primary pathway to the receptors is through contaminated groundwater. A downgradient active well (base well 42) is located about 5200 feet to the northwest of Site NS-2 at building 11-200. Groundwater migration rates have been established at the site; thus, time of travel to the well cannot be determined. However, well 42 is an artesian well, drilled to a depth of 225 feet (Phase II, Stage 2 Report, Dames and Moore, 1987). The wells samples at Site NS-2 are 56 feet deep or less. The water from base well 42 is contained inside a casing as it flows through the zone of probable contamination detected at Site NS-2, and is unlikely to be affected by impacts from the site. A gravel pit located to the immediate southeast of the site, is upgradient and not expected to be impacted by contamination from Site NS-2.

4.2.21.3.2.4 Applicability of Solute Transport Models

The applicability of solute transport models at Site NS-2 cannot be determined by this study due to the need for more information from downgradient wells. Wells installed to the north and northwest of the

site and additional hydrogeological data would provide useful data and more accurate solute transport models. The results from this modeling would help to determine the potential risk of contamination for downgradient water supplies and surface water.

4.2.21.3.2.5 Expected Spatial and Temporal Variations in Concentration

Groundwater flow is primarily to the west-northwest at Site NS-2. The spacial extent of contamination past the site boundaries reaches at least to well NS2-02, which may actually be within the landfill boundary. The contamination may or may not extend to the northwest past the site. Any contamination detected in water from well 42 may or may not have its source at Site NS-2.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or infiltration of additional precipitation. Solubility of the metals is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.21.3.3 Baseline Risk Assessment

The contaminants are evaluated in the following sections with respect to exposure routes and receptors.

4.2.21.3.3.1 Waste Characterization

The primary waste detected at this site is vinyl chloride. Vinyl chloride is used in plastics and as a refrigerant; it has been listed as a human carcinogen by the EPA.

4.2.21.3.3.2 Source and Release Characterization

Materials buried in the landfills at Sites D-5 and D-13 constitute the source of contamination at the site. Organic compounds were introduced to the site from the burial of shop wastes and unknown wastes containerized in drums. The scope of this study does not allow for an accurate estimate of the volume of contamination released since exact types and quantities of materials at the site were never recorded.

4.2.21.3.3.3 Fate and Transport of Contaminants

The fate of organics released to the environment at Site NS-2 includes long-term natural degradation, dispersion of the contaminants through run off, or uptake by living organisms. Another fate for vinyl chloride is volatilization, since the vapor pressure at 5 C for this compound is 2600 mm of Hg.

Transport of contaminants may have occurred by leaching into the water from debris at Site NS-2. Dissolved organic compounds from shop wastes would also percolate downward. At the water table, nonsoluble contaminants would migrate along the hydrogeological gradient. Dissolved contaminants would flow along with the groundwater through the process of advection.

Evidence for contaminant migration is not readily apparent at the site. The actual rate of flow, plume dimensions, and precise direction of contamination migration are not known for this site.

The drinking water well at building 11-200 (base well 42) was last tested for volatile organics and metals in 1987. No volatile organics were detected in the sample, and all metals were detected at levels less than State and EPA standards. It appears that either contamination from Site NS-2 has not reached this well, or the design of the artesian well has prevented its contamination.

4.2.21.3.3.4 Exposure Pathways

The primary pathways of exposure are ingestion of or contact with contaminated groundwater.

4.2.21.3.3.5 Identification of Receptors

Human receptors include anyone drinking from the active well in the area (base well 42) should it become contaminated.

4.2.21.3.3.6 Threat to Human Health

The most significant threat to human health is the drinking of water from base well 42, should contamination be detected in this well. However, this threat is expected to be minimal due to the well design, the distance of the well from Site NS-2, and the dilution of contaminants over that distance.

4.2.21.3.3.7 Carcinogenetic Risks

A compound confirmed as a human carcinogen (EPA Weight of Evidence Group A) was detected in water samples from Site NS-2 at concentrations higher than recommended State of Alaska and EPA levels. Vinyl chloride was detected in a sample from well NS2-01 at a concentration of 2.2 ug/L (over the MCL of 2.0 ug/L).

4.2.21.3.3.8 Threat to Wildlife

There is no anticipated threat to wildlife from contamination of the groundwater at Site NS-2. There are no nearby springs or seeps that would allow the groundwater to reach the surface.

4.2.21.4 Prioritization of Sites for Remedial Alternatives

It is recommended that sites D-5, D-7, D-13 and NS-2 be combined due to their proximity to and the similarity of the contaminants found at these sites. This new site would be assigned a high-priority for remedial alternatives due to contaminant levels exceeding State of Alaska water quality regulations and the evidence of offsite migration. Further investigation at this new site should include installation of 7 additional wells to determine the extent of contamination. Six of the new wells should be located downgradient of the existing wells (2 of them near the gas station). One well should be located near well GW-2B. This well should be screened in the deeper portion of the aquifer, to delineate the extent of vertical contamination. Also, 1 of the 6 new downgradient wells should be a dual completion well, screened in both the upper and lower regions of the unconfined aquifer. Groundwater samples should be obtained from the 7 proposed wells and the 10 presently existing wells. Wells W-2, D13-02, D13-03, GW-1C, and GW-1B were destroyed during gravel pit operations. Each sample should be analyzed for VOC's, TPH, extractable priority pollutants, PCB's and pesticides, anions, and metals including lead. Groundwater samples should be obtained from drinking water well (Base Well 42), located 5200 feet downgradient, to evaluate whether contamination has migrated to the confined aquifer in this location.

A minimum of 2 soil samples should be collected from each of the 7 proposed borings and analyzed for TPH, VOC's, PCBs and pesticides, semivolatile organic compounds, and metals including lead. In addition, expansion of the gravel pit should be halted. If further expansion occurs contaminated groundwater may be exposed.

4.2.22 <u>Results for Site NS-3, Golf Course Seep</u>

It has been reported that, prior to the 1988-89 investigations, fuel of unknown origin has appeared on the ground during springtime in the area of Site NS-3 (Figure 4.2.22.1), immediately north of the Golf Pro Shop. The fuel flowed into a drainage ditch that parallels Post Road. During the 1988-89 RI/FS field investigations, however, no fuel was seen in the area.

4.2.22.1 Presentation of Results at Site NS-3

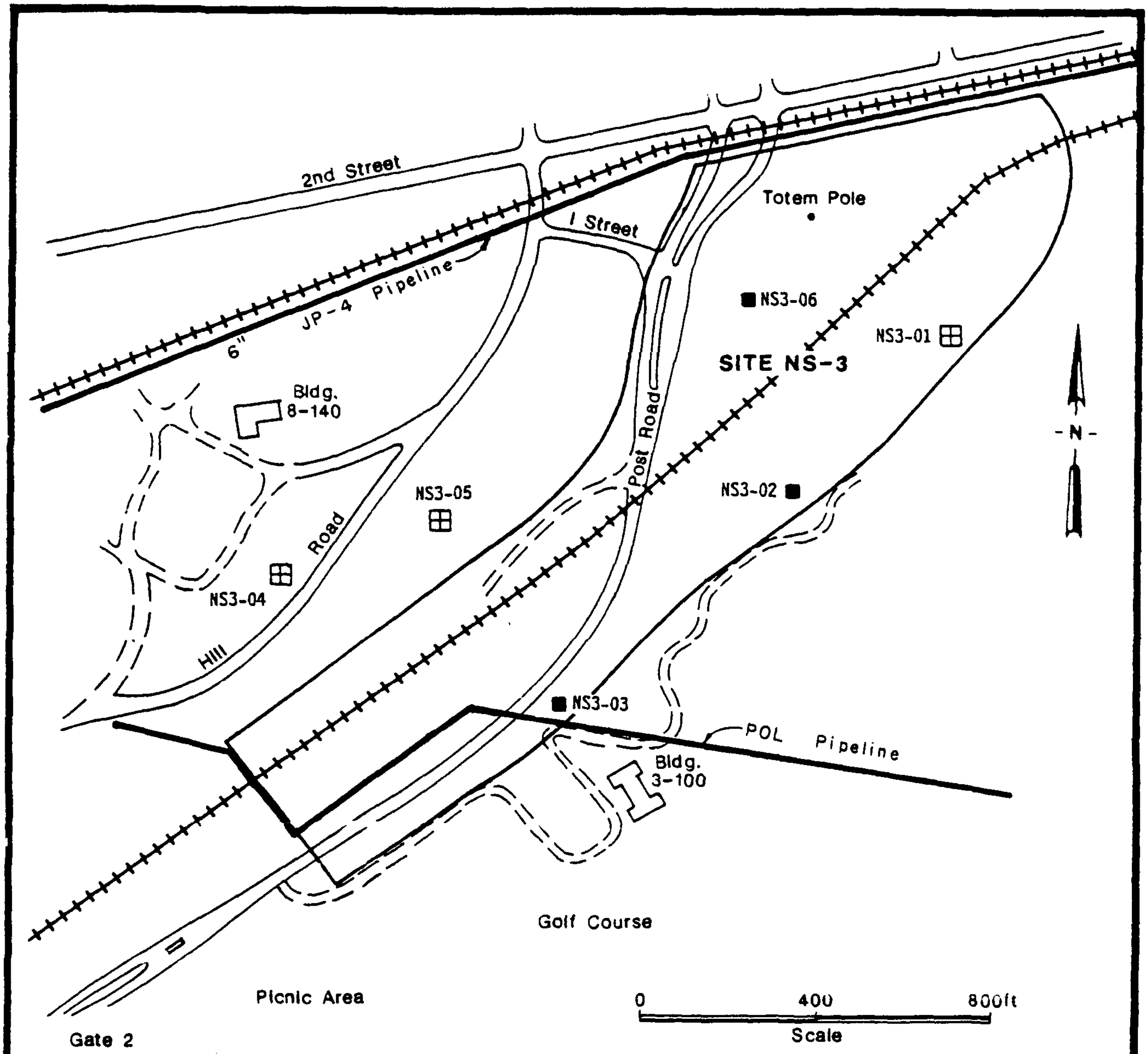
Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site maps.

4.2.22.1.1 Site Geology

Site NS-3 is located on a slope immediately above Ship Creek. The elevation of the site ranges from 120 to 150 feet. The site is located on late-Quaternary coarse-grained sand and gravel alluvial deposits of Ship Creek and an abandoned tributary to Ship Creek extending to the north. This alluvium is covered by two 10-foot high railroad and road embankment fills which bisect the site. The lower elevations of the site are vegetated with scattered cottonwood trees to 50 feet in height. The upper portions of the site have been graded and planted with grass.

4.2.22.1.1.1 Records Search

A records search revealed no documents showing dry wells on the site. However, a POL line belonging to the U.S. Army traverses the area. A U.S. Air Force JP-4 pipeline parallels Second Street at the north end



Legend:

NS3-02 ■ Monitoring Well Location Stage 3

NS3-01 ⊞ Stage 3 Borehole

┼┼┼┼┼┼┼ Railroad

LOCATION MAP
SITE NS-3

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.22.1

of the site. This pipeline previously had minor spills according to Air Force liquid fuels maintenance (LFM) personnel (personal communication, Russ Quinn LFM Superintendent, August 1988).

4.2.22.1.1.2 Borings

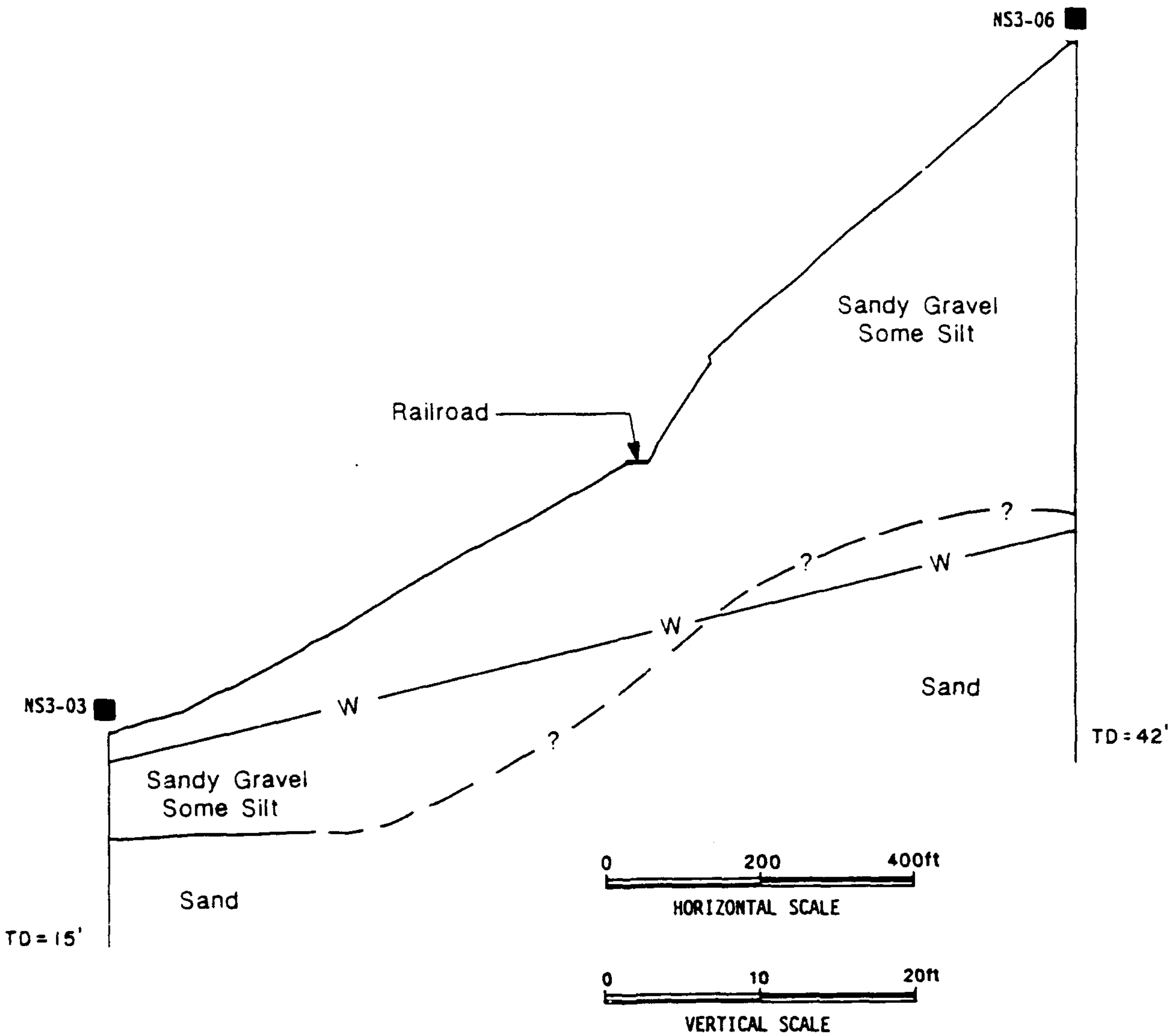
Six borings were drilled at Site NS-3. Three of the borings were completed as monitoring wells. Logs of these wells and borings are presented in Appendix C. These logs detail the lithology and subsurface conditions encountered at each borehole. A gamma log of well N53-03 is presented in Appendix D. A schematic geological cross section of the site is shown in Figure 4.2.22.2.

4.2.22.1.2 Site Hydrogeology

Site NS-3 is underlain by coarse sands with gravels with some silts and clays. The water table ranges in depth from approximately 1 foot to 40 feet deep. The direction of groundwater flow is based on a comparison of regional trends and waterlevel measurements at 3 wells at the site (Figure 4.2.22.3). The groundwater flow is south to south-southeast above the bluff near Post Road and southwest below the bluff. Hydraulic gradients in the area range from about 40 to about 250 feet per mile. Hydraulic conductivity values have not yet been estimated for this site.

4.2.22.1.3 Analytical Results

Field analytical results and observations and laboratory analytical results are discussed in the following sections.



Legend:

NS3-03 ■ Monitoring Well Location Stage 3

—W— Projected Water Table

— — — Geologic Contact, Dashed Where Inferred

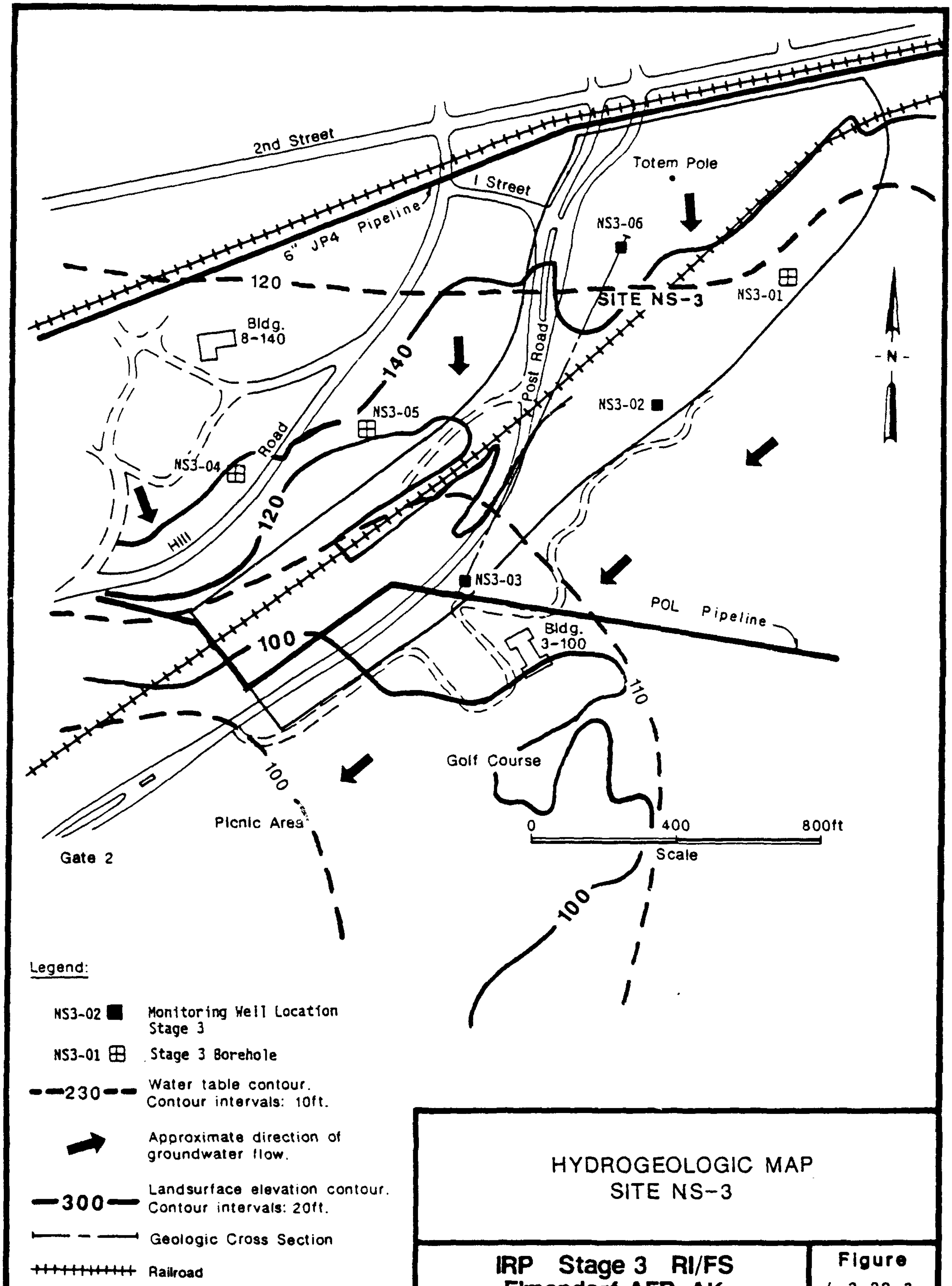
Notes:

1. Horizontal scale: 1 inch = 200 feet.
2. Vertical scale: 1 inch = 10 feet.
3. Location of cross section shown on Figure 4.2.22.3

GEOLOGIC CROSS SECTION
SITE NS-3

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.22.2



HYDROGEOLOGIC MAP
SITE NS-3

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.22.3

4.2.22.1.3.1 Field Analytical Results and Observations

Results of a soil gas survey conducted at Site NS-3 are presented on Figure 4.2.22.4 and in Table 4.2.22.1. Isoconcentration contours have been drawn based on the findings of the field analysis. In addition to the soil gas survey, visual observations were made in the field at all subsurface investigative sites. At several borings there were no indications of contamination either as stains, odor, or HNu reading. These sites included borings NS3-01, NS3-02, NS3-03, NS3-04, and NS3-05. An HNu reading of 1 ppm was recorded on a soil sample at the 25 feet depth in well NS3-06.

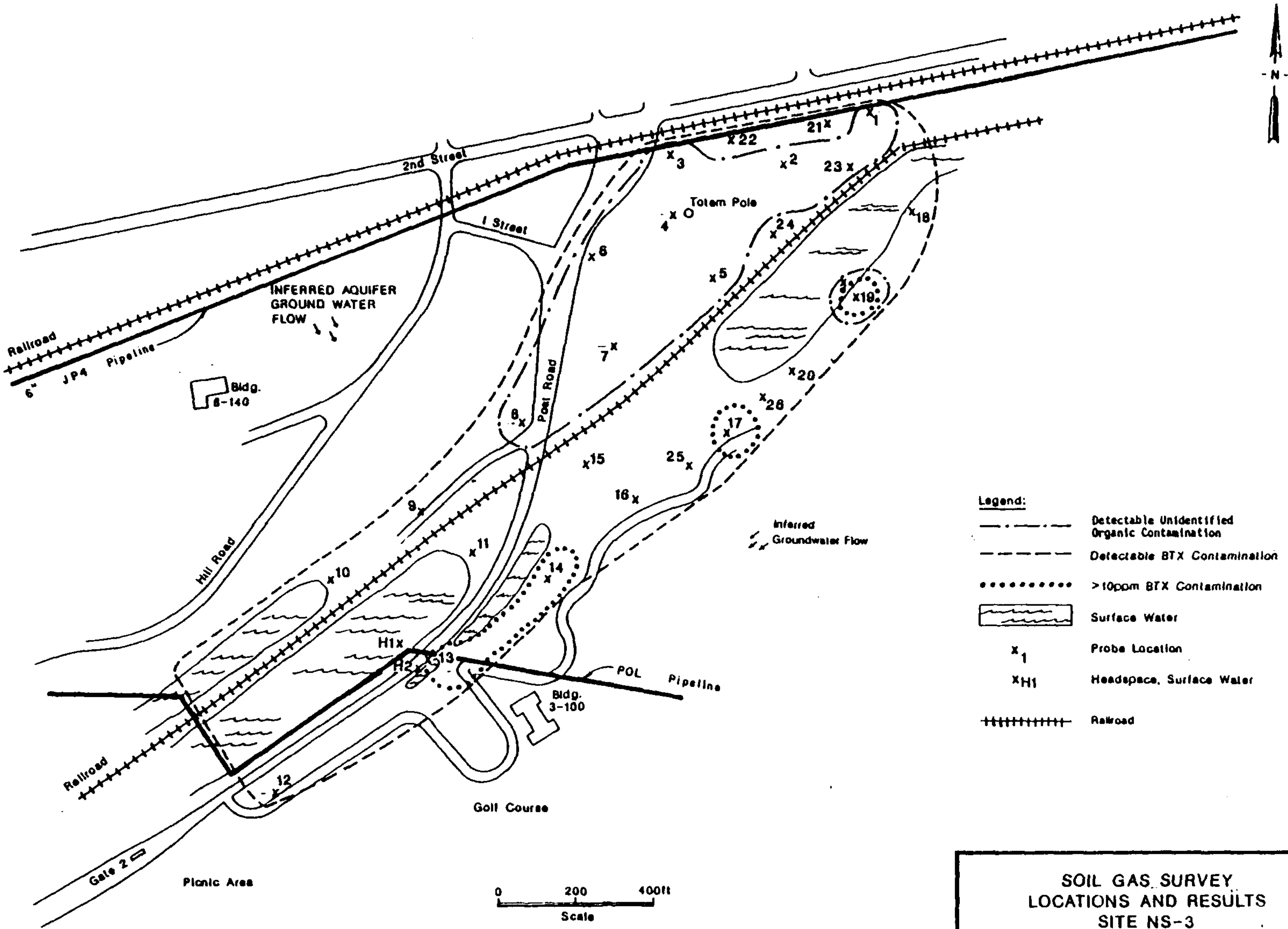
Field parameters measured at Site NS-3 during groundwater sampling are present in Table 4.2.22.2.

4.2.22.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Site NS-3 is presented in Table 4.2.22.3, and the sample plan for the base-wide field investigations program is included in Appendix B. Major organic contaminants identified from the laboratory analyses of samples collected at Site NS-3 are plotted on Figures 4.2.22.5 and 4.2.22.6. A separate map for both identified hydrocarbon contaminants is provided; the analyte concentrations are plotted next to the corresponding well or test boring. Sampling depth is included for the soil samples. Isoconcentration lines were not drawn due to few points having detectable contamination for each analyte.

4.2.22.1.4 Analytical Results Table

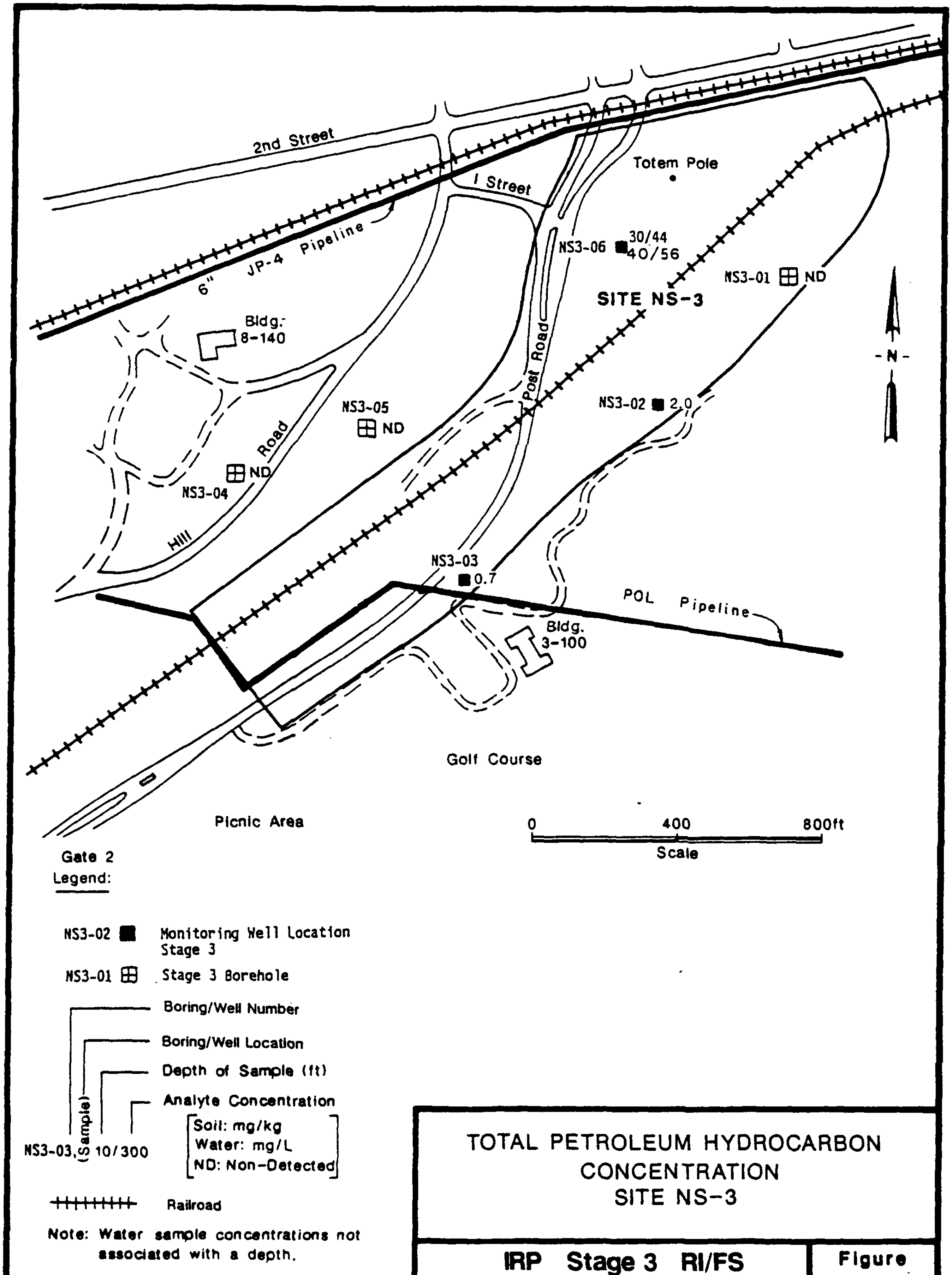
Laboratory analytical results for detected parameters at Site NS-3 are presented in Table 4.2.22.4.



SOIL GAS SURVEY
LOCATIONS AND RESULTS
SITE NS-3

IRP Stage 3 RI/FS
Elmendorf AFB, AK

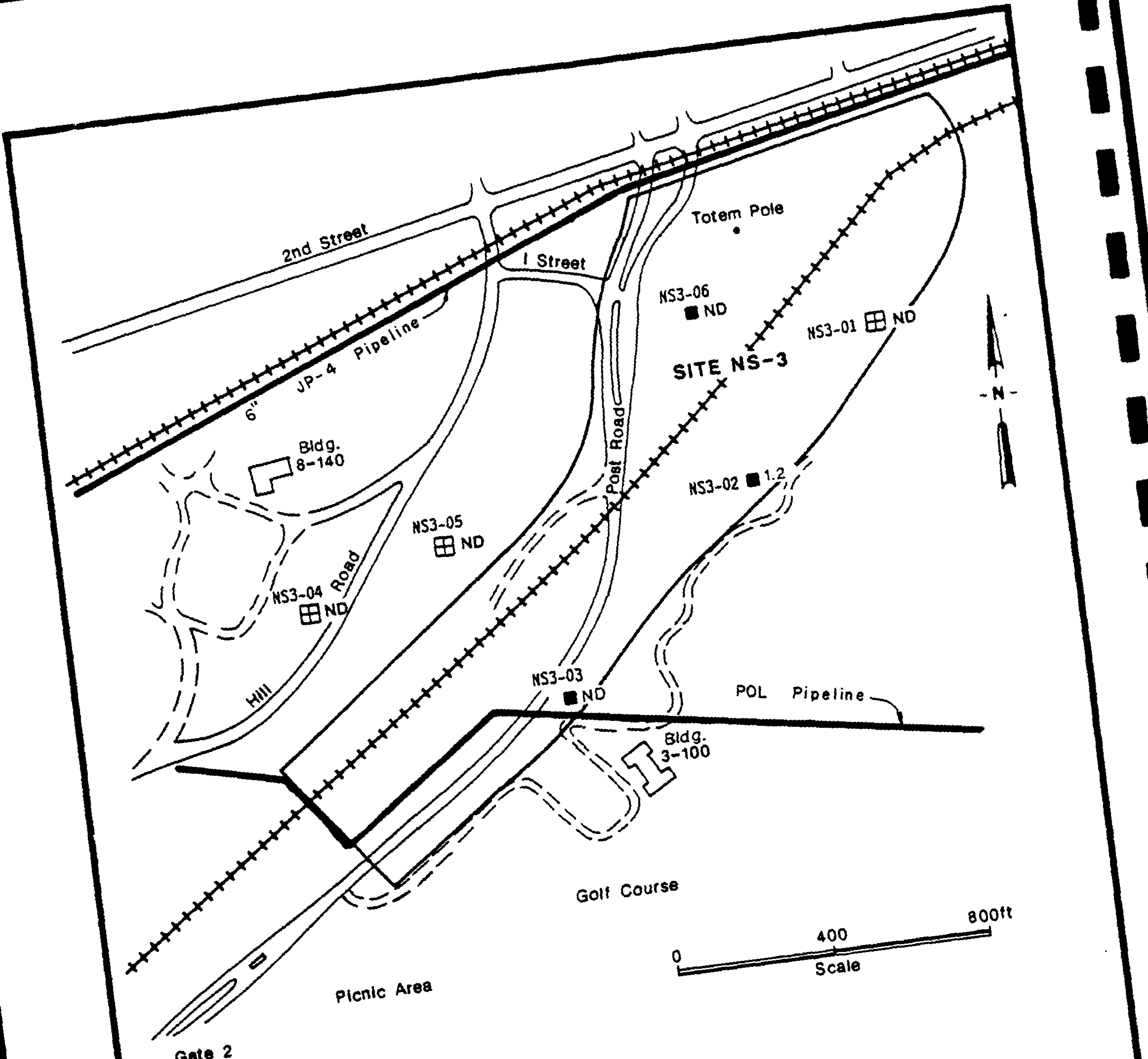
Figure 4.2.22.4



TOTAL PETROLEUM HYDROCARBON CONCENTRATION SITE NS-3

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.22.5



Legend:

NS3-02 ■ Monitoring Well Location Stage 3

NS3-01 ⊞ Stage 3 Borehole

- Boring/Well Number
- Boring/Well Location
- Depth of Sample (ft)
- Analyte Concentration [Soil: mg/kg Water: µg/L ND: Non-Detected]

NS3-03 (Sample) 10/300

+++++++ Railroad

Note: Water sample concentrations not associated with a depth.

TRICHLOROETHENE CONCENTRATION SITE NS-3

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.22.6

Table 4.2.22.1 Summary of Soil Gas Chromatograph Analyses at Site NS-3

Probe No.	Depth (ft)	Benzene (ppm)	Toluene (ppm)	Xylenes (ppm)	Unidentified Organics (ppm)	Comments
1	10	-	TR	6.26	2.16	Unidentified organics are at 1.7 RT
2	10	.04	.03	TR	.01	
3	10	.25	.94	2.56	.26	
4	5	-	1.94	TR	.13	
	10	-	.60	TR	.21	
5	7.5	-	.29	TR	.03	
6	10	-	1.42	TR	.21	
7	10	.25	1.57	TR	.17	
8	10	-	.78	TR	.89	
9	10	-	.87	-	TR	
10	10	-	2.43	-	-	
11	10	-	.42	2.92	-	
12	10	.16	.22	TR	-	
13	5	6340	-	-	-	JP4, diesel, fuel odor
14	10	15.85	7.53	1.67	-	
15	10	1.66	TR	.15	-	
16	10	6.09	TR	2.37	-	
17	10	-	15.9	-	-	
18	10	TR	4.0	TR	-	
19	10	-	-	14	3.13	Water to surface
20	10	-	.10	TR	-	
21	10	-	TR	.44	-	
22	10	-	.95	1.49	-	
23	5	-	TR	TR	-	
24	5	-	3.72	3.84	TR	
25	5	-	-	4.19	TR	Water to surface
26	5	1.48	TR	.37		Headspace of surface water
H1	headspace	.05	TR	TR	-	
H2	headspace	.04	-	-	-	
H3	headspace	-	-	2.48	-	

Note: Unidentified organics are reported in benzene equivalent ppm.
TR - Trace
RT - Retention Time

Table 4.2.22.2 Field Parameters Site NS-3

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
NS3-02	8/23/88	9.0	249	7.44	159	No odor or sheen
NS3-03	8/23/88	11.0	422	4.88	264	No odor or sheen
NS3-06	8/23/88	9.0	350	7.11	163	No odor or sheen

Table 4.2.22.3 Requested Analyses for Laboratory Samples at Site NS-3

<u>SOIL</u>

Test Number	Analysis
418.1	Total Petroleum Hydrocarbons
624	Volatile Organic Compounds
160.3	Soil Moisture Content

<u>WATER</u>

Test Number	Analysis
601	Purgeable Halocarbons
602	Purgeable Aromatics
625	Extractable Priority Pollutants
418.1	Total Petroleum Hydrocarbons

Table 4.2.22.4

Analytical Results - Site NS-3

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	NS3-06 30'-31.5' 0687-SO-113 GS-88-0001 001099-0001	NS3-06 40'-41.5' 0687-SO-113 GS-88-0002 001099-0002	NS3-01 10'-11.5' 0687-SO-109 GS-88-0001 001043-0001	NS3-01 25'-26.5' 0687-SO-109 GS-88-0002 001043-0002	NS3-02 0687-NG-111 GN-88-0003 001347-0004	NS3-04 15'-16.5' 0687-SO-108 GS-88-01 001022-0004
Total Petroleum Hydrocarbons	EPA 418.1			44	56			2.0	
Total Solids	160.3	%		90.4	82.8	84.2	87.9		95.6
Trichloroethene	EPA 601	ug/L	5.0					1.2	

Table 4.2.22.4

Analytical Results - Site NS-3

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	NS3-04 25'-26.5' 0687-SO-108 GS-88-02 001022-0005	NS3-05 15'-16.5' 0687-SO-112 GS-88-0001 001026-0004	NS3-05 20'-21.5' 0687-SO-112 GS-88-0002 001026-0005	NS3-02 10'-11.5' 0687-SO-111 GS-88-0001 001043-0005	NS3-02 25'-26.5' 0687-SO-111 GS-88-0002 001043-0006	NS3-03 0687-NG-110,GN-88-0003 001370-0005
Total Petroleum Hydrocarbons	EPA 418.1								0.7
Total Solids	160.3	%		97.0	95.9	88.0	64.5	84.0	
Trichloroethene	EPA 601	ug/L	5.0						

Table 4.2.22.4

Analytical Results - Site NS-3

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	NS3-03 5'-6.5' 0687-SO-110 GS-88-0001 001026-0002	NS3-03 10'-11.5' 0687-SO-110 GS-88-0002 001026-0003
Total Petroleum Hydrocarbons	EPA 418.1				
Total Solids	160.3	%		93.0	85.4
Trichloroethene	EPA 601	ug/L	5.0		

4.2.22.1.5 Discussion of Analytical Data

Petroleum hydrocarbon compounds were detected at Site NS-3. However, concentrations were generally low and isolated to 1 or 2 borings. (Figures 4.2.22.5 and 4.2.22.6). For example, trichloroethene was detected at a concentration of 1.2 ug/L in water from well NS3-02. Total petroleum hydrocarbons were detected only in water samples from wells NS3-02 and NS3-03 at concentrations of 2.0 and 0.7 mg/L, respectively. Petroleum hydrocarbons were detected in soil samples from NS3-06 at concentrations of 44 and 56 mg/kg at depths of 30 and 40 feet, respectively.

4.2.22.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at Site NS-3 include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.22.2.1 Loss of Samples

No soil or water samples collected for laboratory analyses were lost from Site NS-3.

4.2.22.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is possible, but unlikely, that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. However, acetone, a compound commonly associated with laboratory procedures, was detected in a duplicate soil sample from well NS3-06.

4.2.22.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Twelve soil samples were collected from 3 well and 3 boring locations at Site NS-3. One water sample was collected from each well. No out-of-control conditions occurred during drilling and sampling operations at the site.

4.2.22.3 Significance of Findings

Analytical methods detected volatile organic compounds and petroleum hydrocarbons in water samples from Site NS-3. Soil samples collected at well NS3-06 had total petroleum hydrocarbon concentrations of 44 and 56 mg/kg at depths of 30 and 40 feet, respectively. Trichloroethene was detected in water from well NS3-02, but at a concentration below the State of Alaska Primary Water Quality Standard. Petroleum hydrocarbons were detected in wells NS3-02 and NS3-03. However, water samples from these wells were in compliance with State of Alaska standards for petroleum hydrocarbons since no sheen or odors were detected during sampling.

The source of petroleum hydrocarbons and volatile organics in the water at this site is unknown. A JP-4 pipeline parallels Second Street north of the site, and a POL pipeline crosses the site near NS3-03 (Figure 4.2.22.1). Either of these pipelines may be the source of contamination. The specific quantity and type of petroleum product spilled or leaked has never been determined. It is not known if this is an ongoing leak, or the result of a past spill.

Pathways of exposure are contact with and ingestion or uptake of contaminated ground or surface water. Receptors of the contamination are humans, wildlife, fish and plants.

4.2.22.3.1 Zones of Contamination

The data density at the site allows for some generalization of the zones of contamination. A soil gas survey at Site NS-3 showed detectable BTX contamination throughout the area south of Second Street and west of Hill Road (Figure 4.2.22.4). Several areas of BTX contamination exceeding 10 ppm were detected during the survey. Wells NS3-02 and NS3-03 were completed in or near these areas. Laboratory analyses of the water samples from these wells confirmed the presence of petroleum hydrocarbons and/or volatile organics. Soil gas survey readings in the vicinity of well NS3-06 and boreholes NS3-01 and NS3-05 indicated BTX contamination. However, soil samples from well SP3-06 and boreholes NS3-01 and NS3-05 did not have detectable contamination. General concentration lines have been constructed for the soil gas data, but there is insufficient data from other sources to allow three-dimensional temporal or higher-definition spatial mapping.

4.2.22.3.2 Contaminant Migration

Contaminants are probably migrating in the groundwater as evidenced by petroleum hydrocarbons detected in both wells NS3-02 and NS3-03. Although the actual spill or leak site is not known, well NS3-03 is the most downgradient well. Contamination by petroleum hydrocarbons was detected in this well at a lower concentration than was detected in well NS3-02, located immediately upgradient. The organic contamination in these wells may originate at Sites SP-4 and SP-11 (Sections 4.2.12 and 4.2.14) located immediately upgradient from Site NS-3.

4.2.22.3.2.1 Potential for Offsite and Off-Base Migration

The potential for offsite and off-Base migration of contamination at Site NS-3 is unknown. The actual spill site and site boundaries have

not been clearly established. Although contamination appears to be migrating and was detected in the most downgradient well, well NS3-03, it is not known if this well is situated outside of site boundaries. It is possible that contamination found in 2 wells on site has its origin at Sites SP-4 and SP-11 which are located upgradient.

The soil gas survey detected contamination encompassing about 50 acres. Since the site boundaries are not known, evidence supporting contaminant migration cannot be verified.

Groundwater flow is to the south and south-southwest and the nearest base boundary in those directions is about 2000 feet distant. Ship Creek is less than 500 feet to the southwest. Should contamination from Site NS-3 reach the creek, it would be carried off base by the creek water.

4.2.22.3.2.2 Rate and Direction of Migration of Contaminants Based on Hydrogeologic Properties

The hydrogeologic assessment at the site inferred that the direction of groundwater flow is to the south and south-southwest with a gradient ranging between 40 and 250 feet per mile. The rate of migration of the contaminants in the groundwater will depend upon the actual groundwater flow rate, the point of release to the groundwater, factors affecting the solubility (e.g., water pH and temperature) at any given time during the migration, and the soil chemistry. These factors are subject to temporal and seasonal changes which have not been delineated. This study has insufficient data to make an accurate estimate of the migration rate of the dissolved chemicals.

4.2.22.3.2.3 Time of Travel to Receptors

The primary receptors at present are humans, wildlife, fish and plants. Primary pathways are ingestion of contaminated ground and surface water.

A secondary exposure route would be the ingestion of contaminated plants or fish. Ship Creek is located less than 500 feet southwest of Site NS-3. Hydraulic conductivity values have not been established for this site; thus, time of travel to the creek cannot be estimated. Any contamination reaching the creek is expected to become highly diluted by the creek water. Several ponds or marshy areas are adjacent to or within the presumed site boundaries. Contamination may reach these ponds even if they are not directly downgradient. It is suspected that the ponds have an outlet to Ship Creek.

Active drinking water well, well BW-52 is less than 500 feet downgradient of the site at building 23-100. This well was sampled as part of this study (Section 4.2.24). Time of travel to the well may cannot be estimated until hydraulic conductivity values have been established. However, base well 52 is an artesian well, drilled to a depth of 166 feet (Phase II, Stage 2 Report, Dames and Moore, 1988). The water from well is contained inside a casing as it flows through the zone of potential contamination detected at Site NS-3, and is unlikely to be affected by impacts from the site.

4.2.22.3.2.4 Expected Spatial and Temporal Variations in Concentration

A soil gas survey detected contamination by BTX and unidentified organics encompassing an area of about 50 acres (Figure 4.2.22.4). The actual spill site is unknown, but may be located to the north in a pipeline that parallels Second Street or at a POL pipeline crossing the site near well NS3-03.

The spatial extent of contamination in groundwater reaches at least to well NS3-03, which is about 1200 feet downgradient of the pip`line that parallels Second Street. It is not known if this well is located upgradient or downgradient of the JP-4 pipeline that crosses the site. Well NS3-02 is also contaminated and is about 1000 feet downgradient of the Second Street pipeline. This well is located upgradient of the JP-4 pipeline. No other wells or boreholes sampled at Site NS-3 encountered contamination.

Temporal variations may exist due to seasonal changes in groundwater conditions. Flow rates and directions may be greatly changed by freezing and/or inflow of additional precipitation. Solubility of the contaminants is also affected by changes in water pH and temperature that may occur on a seasonal basis.

4.2.22.3.3 Baseline Risk Assessment

The contamination in relation to exposure routes, receptors and health effects are evaluated in the following sections.

4.2.22.3.3.1 Waste Characterization

The primary wastes at this site are petroleum hydrocarbons and trichloroethene. Total petroleum hydrocarbons were detected in water samples from wells at Site NS-3. In general, petroleum hydrocarbons are not highly toxic, but can have slight anesthetic effects. Trichloroethene was detected in 1 water sample. This volatile organic is used as a degreaser and a solvent. Trichloroethene is slightly soluble in water.

4.2.22.3.3.2 Source and Release Characterization

A potential source for petroleum hydrocarbons and trichloroethene detected may have been a leak in either a JP-4 or POL pipeline. The specific amount or type of fuel spilled was never recorded. Another

potential source of the contamination is spills and leaks associated with Sites SP-4 and SP-11.

4.2.22.3.3.3 Fate and Transport of Contaminants

The fate of petroleum hydrocarbons and trichloroethene released to the environment at Site NS-3 includes long-term natural degradation, dispersion of the contaminants through runoff, or uptake by living organisms. Volatilization is another possible fate for trichloroethene since its vapor pressure (v.p.) is greater than 1 mm of mercury (v.p. 100 mm at 32 C).

Dissolved contaminants can be transported from the site through percolation to the saturated groundwater zone and subsequent migration with the groundwater through the process of advection. Additional transport can occur in the form of surface runoff or release of vapor to the atmosphere. Contaminated water from the site can be transported through human intervention.

4.2.22.3.3.4 Exposure Pathways

The exposure pathway for humans, fish, and wildlife is contact with or ingestion of contaminated ground or surface water, fish or plants.

4.2.22.3.3.5 Identification of Receptors

Receptors are humans, fish, wildife and plants. Human receptors include anyone drinking from base well 52. In addition, humans may be exposed to contamination through fish or water in Ship Creek or the cooling ponds. Plants in the contaminated area are less likely to become contaminated since surface and near-surface soils show no contamination. However, some of the vegetation in the vicinity may reach to groundwater at depths of 5 to 30 feet.

4.2.22.3.3.6 Threat to Human Health

A possible threat to human health is the drinking of water from base well 52. Base well 52 was sampled as part of this investigation (Section 4.2.24). The sample was found to contain petroleum hydrocarbons (2.0 ug/L), but no volatile organics. Due to the low toxicity of petroleum hydrocarbons, and the design of the well, any threat to human health from drinking water from base well 52 is assessed as low.

Another threat to human health is the drinking of Ship Creek or pond waters, or the ingestion of fish from Ship Creek. As part of this study, water and sediment were collected and analyzed from a point on Ship Creek, southwest and downgradient from Site NS-3. The samples did not contain petroleum hydrocarbons or volatile organic compounds above method detection limits. The threat to human health from exposure to Ship Creek and pond waters is minimal.

4.2.22.3.3.7 Carcinogenetic Risks

Trichlorethene was detected in the groundwater at this site. It has been shown to cause cancer in mice and is a suspected carcinogen (EPA Weight of Evidence class B2). The concentration detected was less than the MCL of 5 ug/L.

4.2.22.3.3.8 Threat to Wildlife

Threat to wildlife is possible through ingestion of contaminated surface water. Ship Creek and the ponds constitute the nearest downgradient surface water bodies. The threat is minimal due to the high dilution rate of creek and pond waters and the fact that this study found creek water and sediments to be uncontaminated.

4.2.22.3.3.9 No Threat to Health

Petroleum hydrocarbons were detected in 2 water samples and trichlorethene was detected in one water sample immediately upgradient from base well 52. This well was not contaminated above State of Alaska standards (Section 4.2.24). Receptors and exposure pathways are present, but the duration and frequency of exposure is not expected to cause adverse health effects.

4.2.22.4 Prioritization of Sites for Remedial Alternatives

The site has been adequately characterized by the installation and sampling of 3 monitoring wells and 2 test borings. A soil gas survey showed the placement of the wells in position to sample groundwater in areas of high soil gas readings. Groundwater samples from these wells were not contaminated at levels above enforceable state standards. Release mechanisms and migration pathways are present but are not expected to cause adverse effects. Site NS-3 is recommended for no further action status.

4.2.23 Discussion of Results for Sites SC-4, SC-5, and SC-6

Sites SC-4, SC-5 and SC-6 (Figure 4.2.23.1) represent sampling locations along Ship Creek, near the Base Golf Course and Post Road Gate. The objective for sampling at these locations was to determine the presence or absence of contamination in Ship Creek water and sediments. They do not represent IRP designated sites which may pose a threat to public health and welfare or the environment.

4.2.23.1 Presentation of Results from Sites SC-4, SC-5, and SC-6

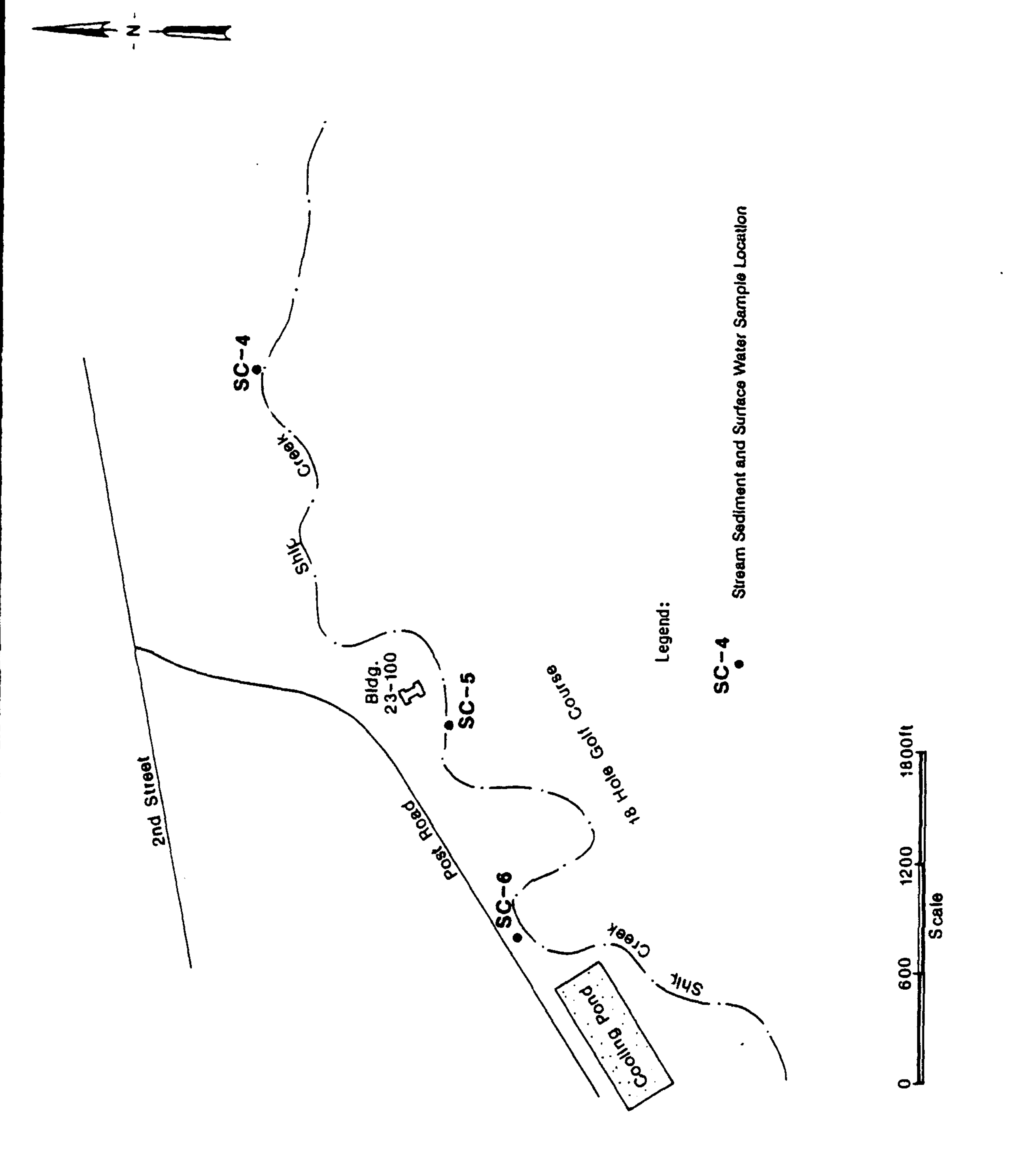
Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site maps.

4.2.23.1.1 Site Geology

Sites SC-4, SC-5 and SC-6 are located along the banks of Ship Creek at elevations ranging from 99 to 121 feet. The terrain is relatively flat, and is part of the Ship Creek floodplain sloping westward toward Knik Arm. The site is underlain by recent alluvium and consists of very coarse sands and gravels with occasional cobbles. The alluvium overlies the silts and clays of the Bootlegger Cove Formation. The depth to the Bootlegger Cove Formation is unknown.

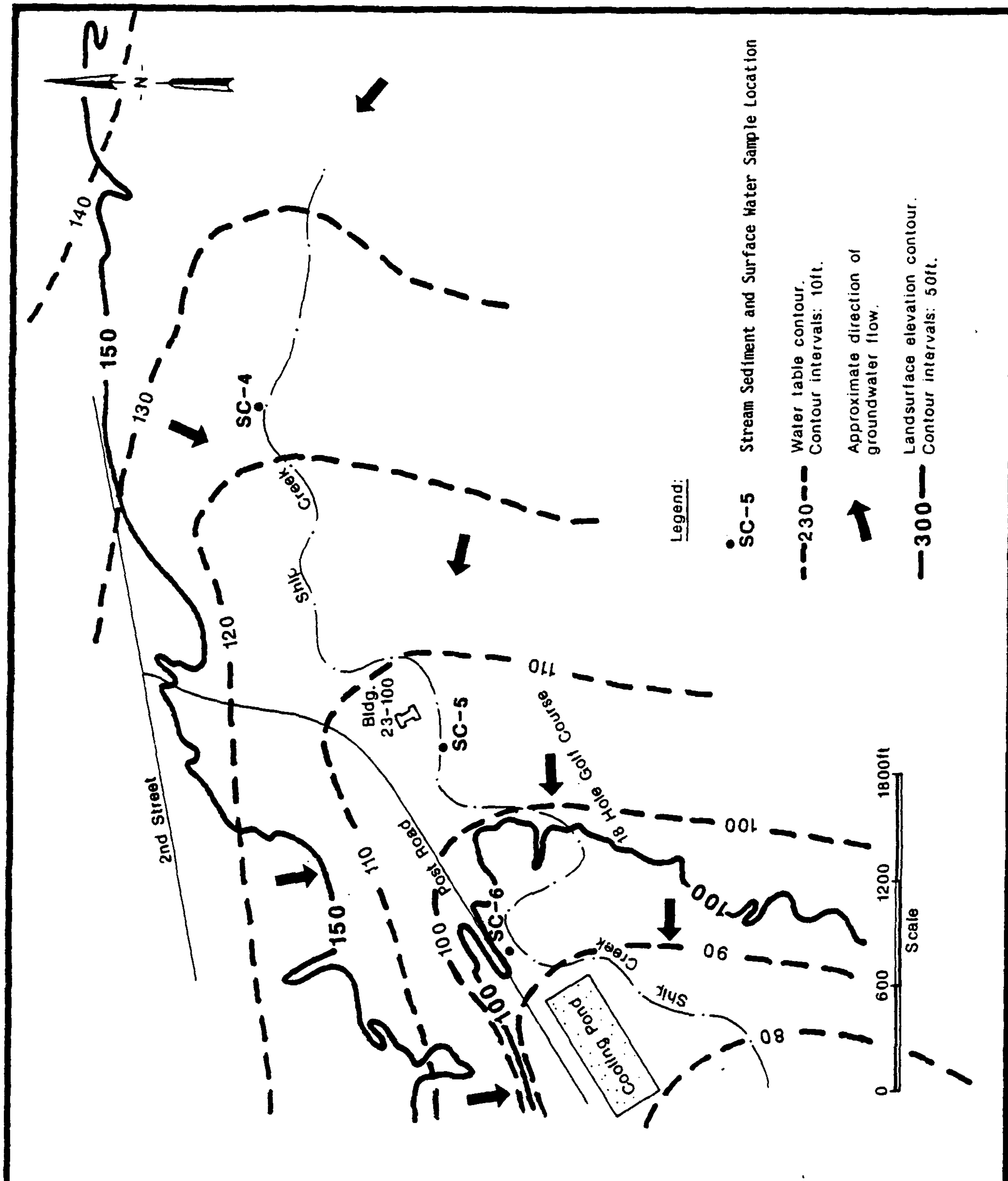
4.2.23.1.2 Site Hydrogeology

Sites SC-4, SC-5, and SC-6 are located on Ship Creek. The Ship Creek valley in this area is incised into a surrounding alluvial plain and the creek gains water from the nearby shallow aquifer system (Figure 4.2.23.2). The stream gradient in this area is approximately 40 to 50 feet per mile. At the time of sampling, streamflow was at moderate flow conditions.



LOCATION MAP
SITES SC-4, SC-5 & SC-6

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.23.1



HYDROGEOLOGIC MAP
SITE SC-4, SITE SC-5 & SITE SC-6

IRP Stage 3 RI/FS **Elmendorf AFB, AK**	**Figure** 4.2.23.2

4.2.23.1.3 Analytical Results

Analytical results and observations and laboratory analytical results are discussed in the following sections.

4.2.23.1.3.1 Field Analytical Results and Observations

No evidence of contamination was observed in the field at these sites.

Field parameters measured at the site during the surface water sampling is presented on Table 4.2.23.1.

4.2.23.1.3.2 Laboratory Analytical Results

The laboratory analytical program for Ship Creek is presented on Table 4.2.23.2, and the sample plan for the base-wide field investigation program is included in Appendix B. No petroleum-based contaminants were identified from the laboratory analysis of samples collected at Ship Creek. Results of analytical tests are presented on Table 4.2.23.3.

4.2.23.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at the Ship Creek sites are presented on Table 4.2.23.3.

4.2.23.1.5 Discussion of Analytical Data

No petroleum hydrocarbons were detected in water samples from Ship Creek. Petroleum hydrocarbons were detected at a concentration of 110 mg/kg at site SC-6 (Figure 4.2.23.3).

Metals such as aluminum (14300 to 17500 mg/kg), iron (24,700 to 30,700 mg/kg), manganese (390 to 1300 mg/kg) and magnesium (7300 to 9200

Table 4.2.23.1 Field Parameters Ship Creek

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
SC-4	8/20/88	11.6	162	7.43	50	No odor or sheen
SC-5	8/20/88	11.5	97	7.50	40	No odor or sheen
SC-6	8/20/88	10.1	99	7.43	98	No odor or sheen

Table 4.2.23.2 Requested Analyses for Laboratory Samples at Ship Creek

Test Number	Analysis
SOIL/SEDIMENT	
Test Number	Analysis
418.1	Total Petroleum Hydrocarbons
6010	ICP Screen
7471	Mercury
8240	Volatile Organic Compounds
8270	Semi-volatile Organic Compounds
335.1	Cyanide
160.3	Soil Moisture Content
WATER	
Test Number	Analysis
300	Common Anions
418.1	Petroleum Hydrocarbons
200.7	ICP Screen (total and dissolved)
6010	Arsenic (total and dissolved)
239.2	Lead (total and dissolved)
245.1	Mercury (total dissolved)
270.2	Selenium (total and dissolved)
601	Purgeable Halocarbons
602	Purgeable Aromatics
625	Extractable Priority Pollutants

Table 4.2.23.3

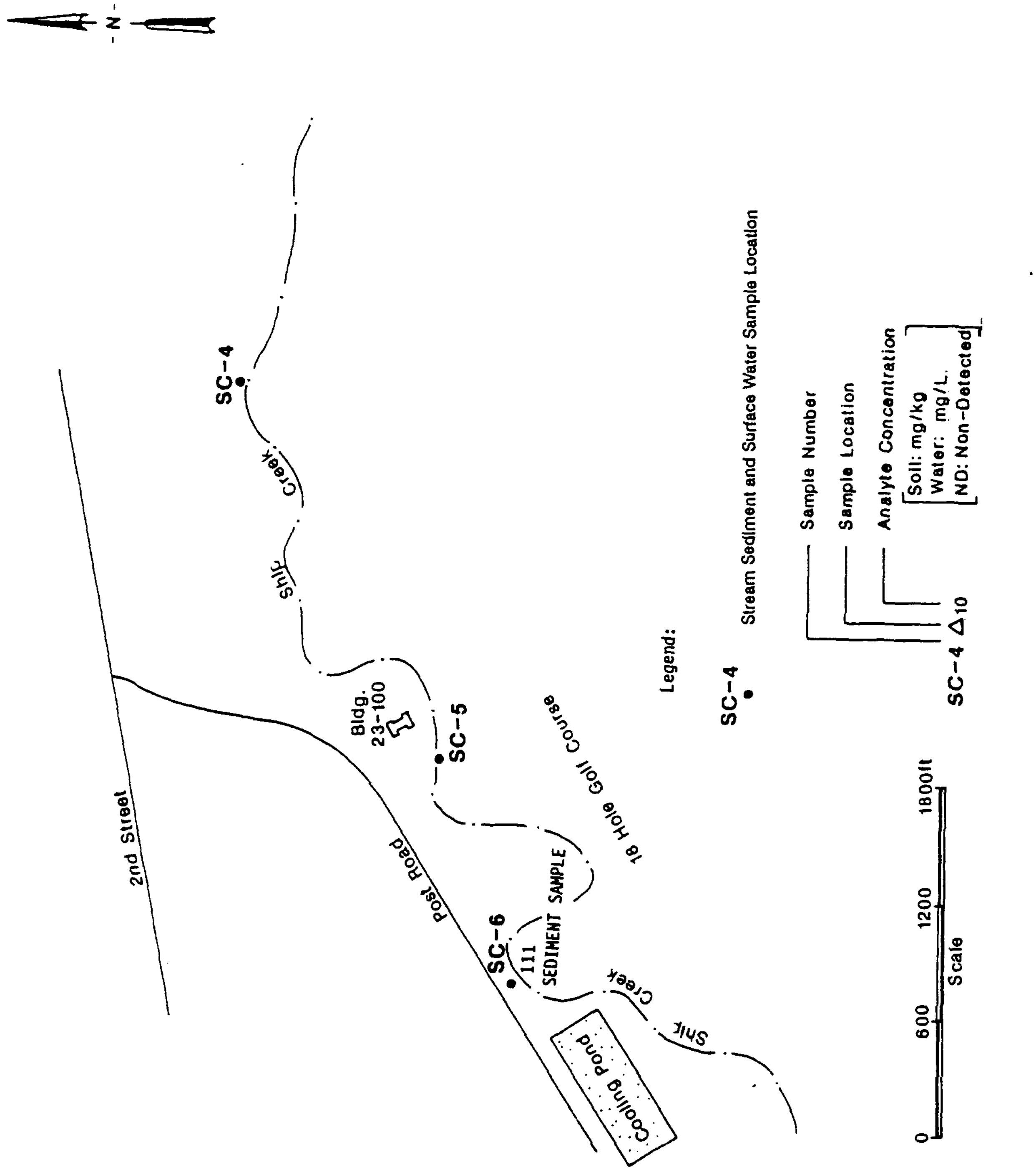
Analytical Results - Site SHIP CREEK

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SC-1 SC-1/32	SC-1 SC-1/33	SC-2 SC-2/34	SC-3 SC-3/32	SC-3 SC-3/36	SC-4 0687-NS-114 GW-88-0002 001170-0004	SC-4 RESAMPLE 0687-NS-114 GW-88-0002R 001324-0014	SC-4 0687-SO-114 GS-88-0001 001170-0003	SC-4 0687-SO-114 GS-88-0001 001170-0003
Aluminum	6010	mg/kg									15324	15324
Barium	6010	mg/kg									82	74
Beryllium	6010	mg/kg									0.3	0.3
Calcium	6010	mg/kg									5371	5529
Chloride	300.0	mg/L	250						1.4			
Chromium	6010	mg/kg	50,000								30	30
Cobalt	6010	mg/kg									11	11
Copper	6010	mg/kg	1,850								24	22
Dissolved Barium	200.7	mg/L	1.0							0.008		
Dissolved Calcium	200.7	mg/L								28.		
Dissolved Lead	239.2	mg/L	0.05									
Dissolved Magnesium	200.7	mg/L								4.5		
Dissolved Manganese	200.7	mg/L	0.05							0.20		
Dissolved Sodium	200.7	mg/L	250							2.6		
Iron	6010	mg/kg									28752	27804
LEAD	239.2	mg/L	0.05		0.009	0.01	0.005					
Magnesium	6010	mg/kg									9163	9005
Manganese	6010	mg/kg	11,000								1311	1027
Nickel	6010	mg/kg									32	30
Potassium	6010	mg/kg										790
Recoverable Calcium	200.7	mg/L							21.			
Recoverable Iron	200.7	mg/L	0.3						0.18			
Recoverable Lead	239.2	mg/L	0.05									
Recoverable Magnesium	200.7	mg/L							3.5			
Recoverable Manganese	200.7	mg/L	0.05						0.15			
Recoverable Sodium	200.7	mg/L	250						2.4			
Sodium	6010	mg/kg									221	237
Sulfate	300.0	mg/L	250						14.			
TDS	160.1	mg/L	500	60		60		60				
TRICHLOROFLUOROMETHANE	601	ug/L			0.54							
Total Petroleum Hydrocarbons	418.1											
Total Solids	160.3	%									63.3	
Vanadium	6010	mg/kg	1,000								52	52
Zinc	6010	mg/kg	10,500								68	62

Table 4.2.23.3

Analytical Results - Site SHIP CREEK

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	SC-5 0687-NS-115 GN-88-0002 001170-0006	SC-5 RESAMPLE 0687-NS-115 GN-88-0002R 001324-0015	SC-5 0687-SO-115 GS-88-0001 001170-0005	SC-6 0687-NS-116 GN-88-0002 001170-0008	SC-6 RESAMPLE 0687-NS-116 GN-88-0002R 001324-0016	SC-6 0687-SO-116 GS-88-0001 001170-0010
Aluminum	6010	mg/kg				14309			17494
Barium	6010	mg/kg				81			113
Beryllium	6010	mg/kg				0.3			
Calcium	6010	mg/kg				5854			7801
Chloride	300.0	mg/L	250	1.1			1.0		
Chromium	6010	mg/kg	50,000			29			38
Cobalt	6010	mg/kg				10			14
Copper	6010	mg/kg	1,850			21			35
Dissolved Barium	200.7	mg/L	1.0		0.008			0.009	
Dissolved Calcium	200.7	mg/L			21.			22.	
Dissolved Lead	239.2	mg/L	0.05		0.002				
Dissolved Magnesium	200.7	mg/L			3.1			3.2	
Dissolved Manganese	200.7	mg/L	0.05		0.033			0.078	
Dissolved Sodium	200.7	mg/L	250		2.4			2.4	
Iron	6010	mg/kg				24715			30733
LEAD	239.2	mg/L	0.05						
Magnesium	6010	mg/kg				7317			8747
Manganese	6010	mg/kg	11,000			390			827
Nickel	6010	mg/kg				27			33
Potassium	6010	mg/kg							
Recoverable Calcium	200.7	mg/L		20.			17.		
Recoverable Iron	200.7	mg/L	0.3	0.17			0.21		
Recoverable Lead	239.2	mg/L	0.05	0.019			0.005		
Recoverable Magnesium	200.7	mg/L		3.1			2.6		
Recoverable Manganese	200.7	mg/L	0.05	0.04			0.06		
Recoverable Sodium	200.7	mg/L	250	2.4			2.0		
Sodium	6010	mg/kg				260			284
Sulfate	300.0	mg/L	250	13.			14.		
TDS	160.1	mg/L	500						
TRICHLOROFLUOROMETHANE	601	ug/L							
Total Petroleum Hydrocarbons	418.1								111
Total Solids	160.3	%				61.5			42.3
Vanadium	6010	mg/kg	1,000			49			59
Zinc	6010	mg/kg	10,500			57			76



TOTAL PETROLEUM HYDROCARBON
CONCENTRATION
SITES SC-4, SC-5 & SC-6

IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.23.3

mg/kg) were detected in sediment samples from the site. The highest concentrations of these metals were detected downstream at Site SC-4, and generally decreased upstream to Site SC-6. Water samples from Ship Creek did not contain aluminum; however, total iron, manganese, and magnesium were detected at concentrations as high as 0.21, 0.15 and 3.5 mg/L, respectively. No dissolved iron was detected. Maximum dissolved manganese and magnesium concentrations were 0.2 and 4.5 mg/L respectively.

Calcium levels in sediment samples (5300 to 7800 mg/kg) and water samples (total: 17 to 21 mg/L), sodium levels in sediment samples (220 to 280 mg/kg) and water samples (total 2.0 to 2.4 mg/L) may be due to the natural mineral content of the surrounding soils. Sulfate and chloride ions were also detected in all water samples collected from Ship Creek at concentrations ranging from 13 to 14 mg/L and 1.0 to 1.4 mg/L, respectively.

Small amounts (less than 120 mg/kg) of other elements such as barium, chromium, cobalt, copper, nickel, vanadium and zinc were detected in sediment samples from all locations. Water samples from all locations contained dissolved barium at concentrations less than 0.02 mg/L.

4.2.23.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at the Ship Creek sites include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.23.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis were lost from the Ship Creek sites.

4.2.23.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in soil or water samples from Ship Creek.

4.2.23.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Three locations along Ship Creek were sampled for surface water and stream sediments. The water samples to be tested for dissolved metals were not originally filtered in the field. This action was corrected by resampling the 3 locations for dissolved metals only, and filtering the samples or site prior to shipment.

4.2.23.2.4 Corrective Actions Applied to Out-of-Control Events, Including a Chronology of Rerunning Samples and Controls

Water samples were retaken from all 3 locations on Ship Creek and tested for dissolved metals. The following table shows when sampling and resampling activities were conducted.

Site Number	Original Sampling Date	Resampling Date
SC-4	8/8/88	8/20/88
SC-5	8/8/88	8/20/88
SC-6	8/8/88	8/20/88

4.2.24 Discussion of Results for the Base Water Wells

Three of the active base wells near Ship Creek (wells BW-1, BW-2, and BW-52, Figure 4.2.24.1) were sampled. Prior investigations reported the presence of contamination in these wells. The objective of sampling at these locations was to determine the continued presence or the absence of contamination. They do not represent IRP designated sites.

4.2.24.1 Presentation of Results for the Base Water Wells

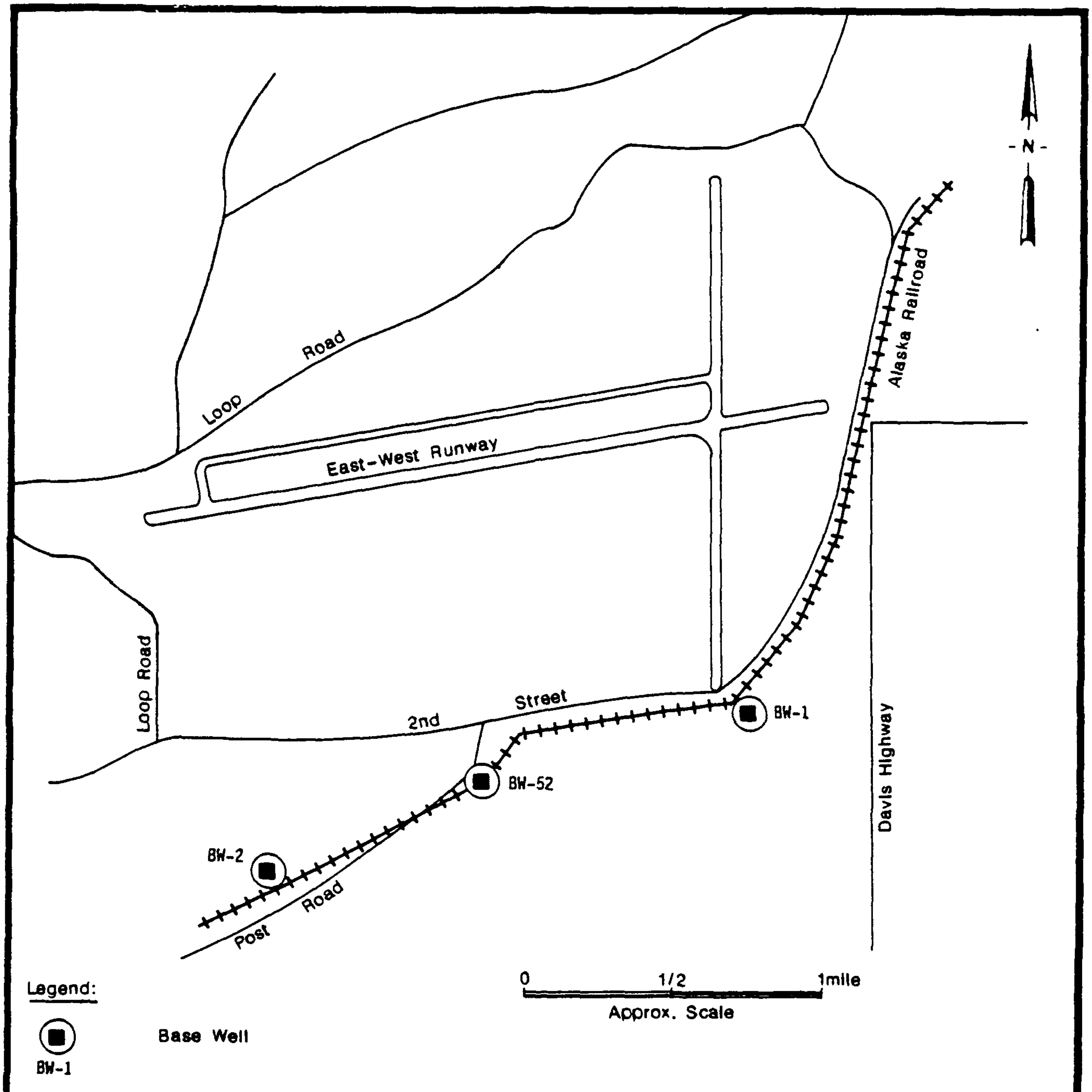
Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site maps.

4.2.24.1.1 Site Geology Base Wells

The active base wells identified as BW-1, BW-2 and BW-52 are located in the Ship Creek floodplain at elevations ranging from about 110 to 125 feet. Base well BW-1 is completed to a depth of 16 feet and presumably is located in late-Quaternary surficial alluvium. Base wells BW-2 and BW-52 are deeper artesian wells and derive water from a confined aquifer in glacio-fluvial deposits underlying the Bootlegger Cove Formation. The Bootlegger Cove Formation is a silt and clay-rich aquitard separating the surficial alluvian from the deeper aquifers.

4.2.24.1.2 Base Wells Hydrogeology (BW-1, BW-2, BW-52)

Base wells BW-2 and BW-52, obtain water from confined aquifers below the Bootlegger Cove Formation. Hydrostatic heads in these aquifers are lower than those in the shallow water table above the bluff line near Ship Creek, indicating the potential for downward groundwater flow from shallow aquifers to deeper aquifers. In the Ship Creek



LOCATION MAP
BASE WELLS 1, 2 & 52

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.24.1

valley, some deep wells are reported to be flowing artesian wells indicating the potential for upward flow into shallower aquifers. Water levels in confined aquifers in this area are known to have been significantly affected by recent and historic pumping patterns in north Anchorage, both on- and off-base. Insufficient recent data are available to construct a reliable potentiometric surface contour map for the confined aquifer system at Elmendorf Air Force Base.

Base well BW-1 is located a few feet from Ship Creek. The well is 10 feet in diameter and 16 feet deep. The well probably obtains a significant amount of its water from Ship Creek as induced infiltration and the remainder as captured shallow groundwater flow.

Base well BW-1 is located in an area where shallow groundwater flows into Ship Creek. A simple analysis of flow paths based on the water table contours suggests that Sites D-3, D-5, D-7 and NS-2 are located upgradient of this well.

4.2.24.1.3 Analytical Results

Field analytical results and observations and laboratory analytical results are discussed in the following sections.

4.2.24.1.3.1 Field Analytical Results and Observations

No visible evidence of contamination was observed during field activities at these wells. Field analysis of the water samples is presented on Table 4.2.24.1.

4.2.24.1.3.2 Laboratory Analytical Results

The laboratory analytical program for the base water wells is presented on Table 4.2.24.2, and the sample plan is included in

Appendix B. Major organic contaminants identified from the laboratory analysis of samples collected at base wells BW-1, BW-2 and BW-52 are plotted in Figures 4.2.24.2 through 4.2.24.6. A separate map for each

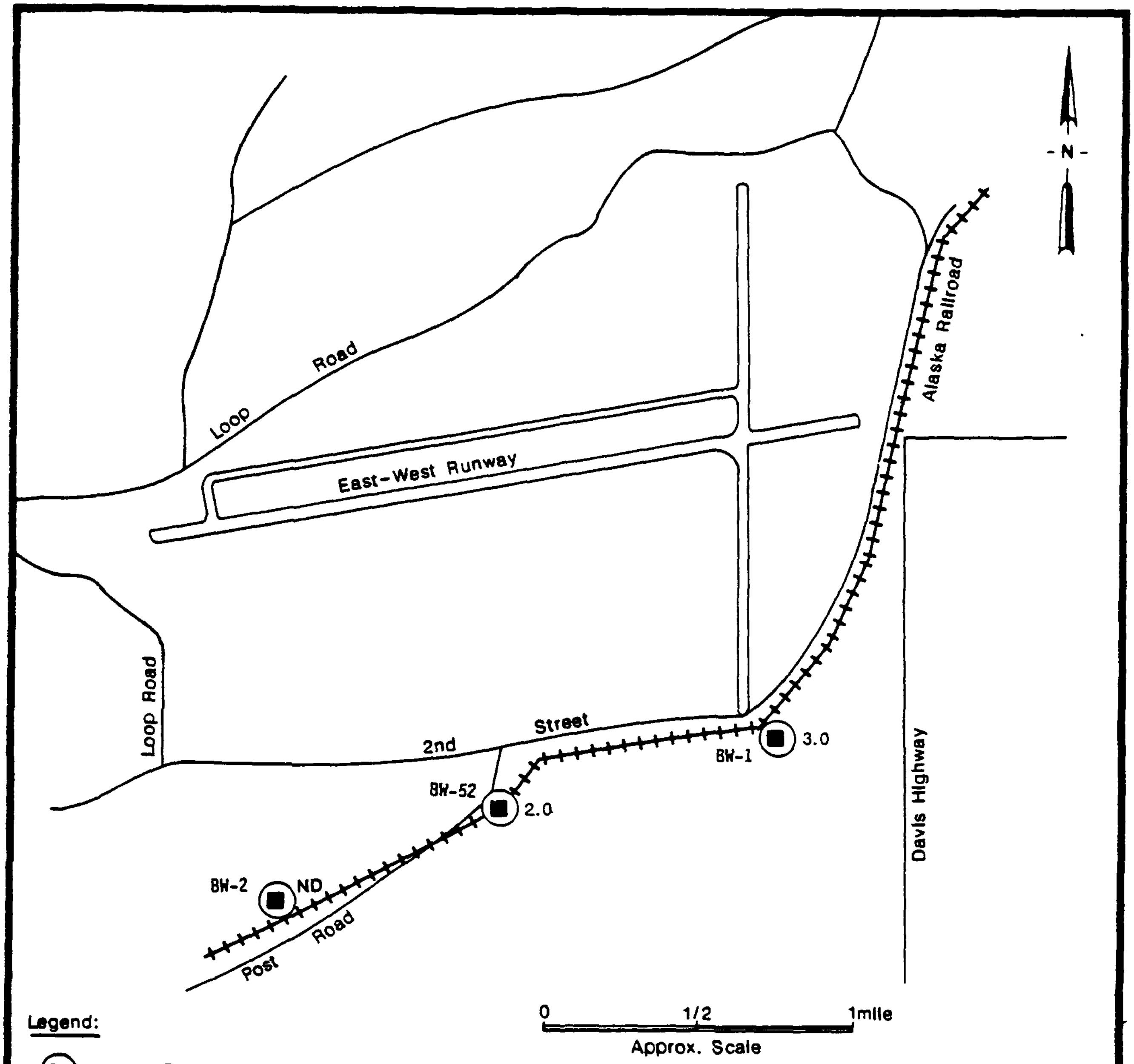
Table 4.2.24.1 Field Parameters Base Wells

Well No.	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
BW-1	8/23/88	10.5	140	7.02	68	No odor or sheen
BW-2	8/23/88	11.0	142	7.75	90	No odor or sheen
BW-52	8/23/88	9.5	170	8.69	108	No odor or sheen

Table 4.2.24.2 Requested Analyses for Laboratory Samples at the Base Water Wells

<u>WATER</u>

Test Number	Analysis
300	Common Anions
418.1	Petroleum Hydrocarbons
200.7	ICP Screen (total and dissolved)
206.2	Arsenic (total and dissolved)
239.2	Lead (total and dissolved)
245.1	Mercury (total dissolved)
270.2	Selenium (total and dissolved)
601	Purgeable Halocarbons
602	Purgeable Aromatics
625	Extractable Priority Pollutants



Legend:

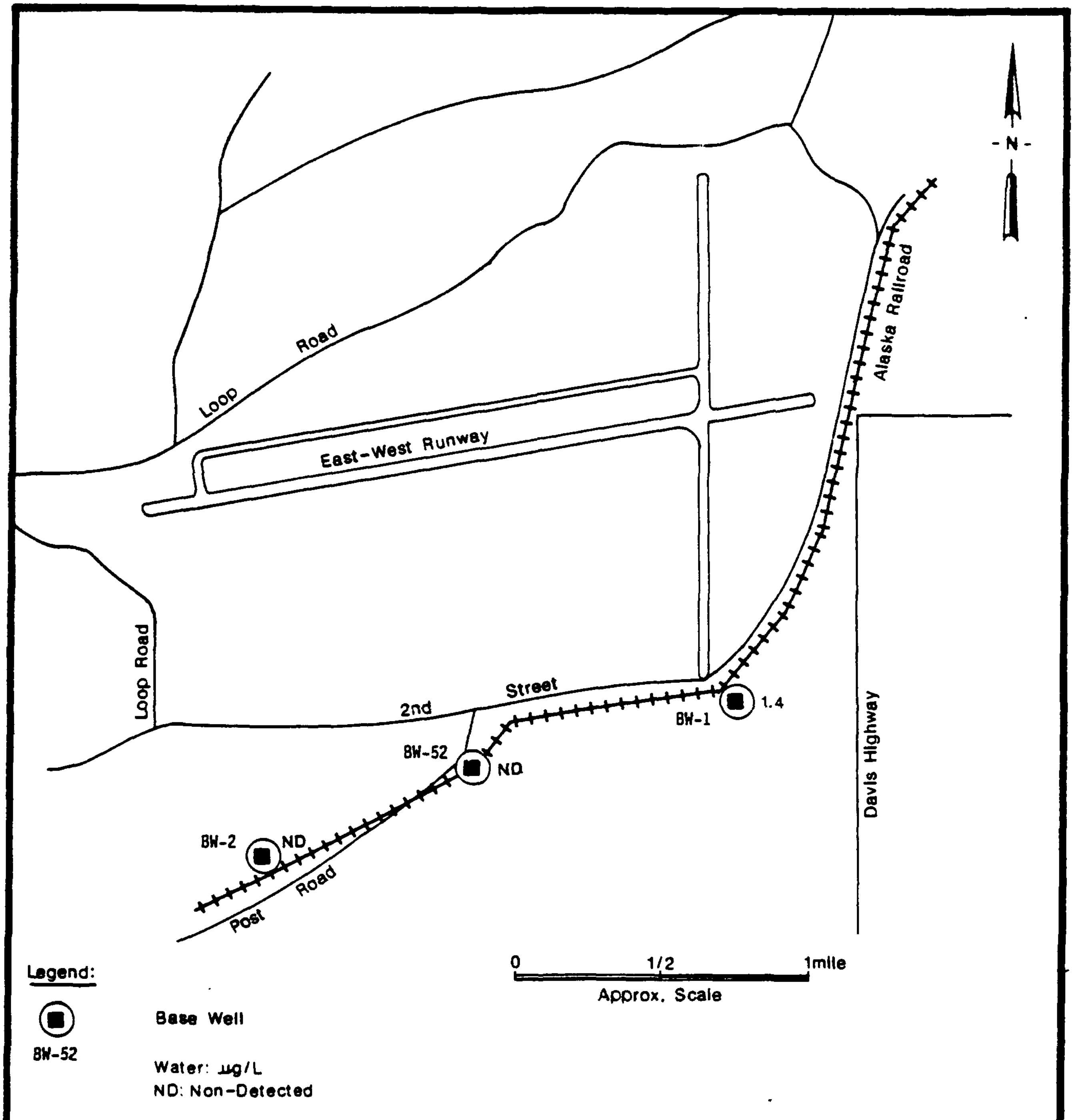
BW-2 — Base Well

Water: mg/L

ND: Non-Detected

TOTAL PETROLEUM HYDROCARBON CONCENTRATION BASE WELLS 1, 2 & 52

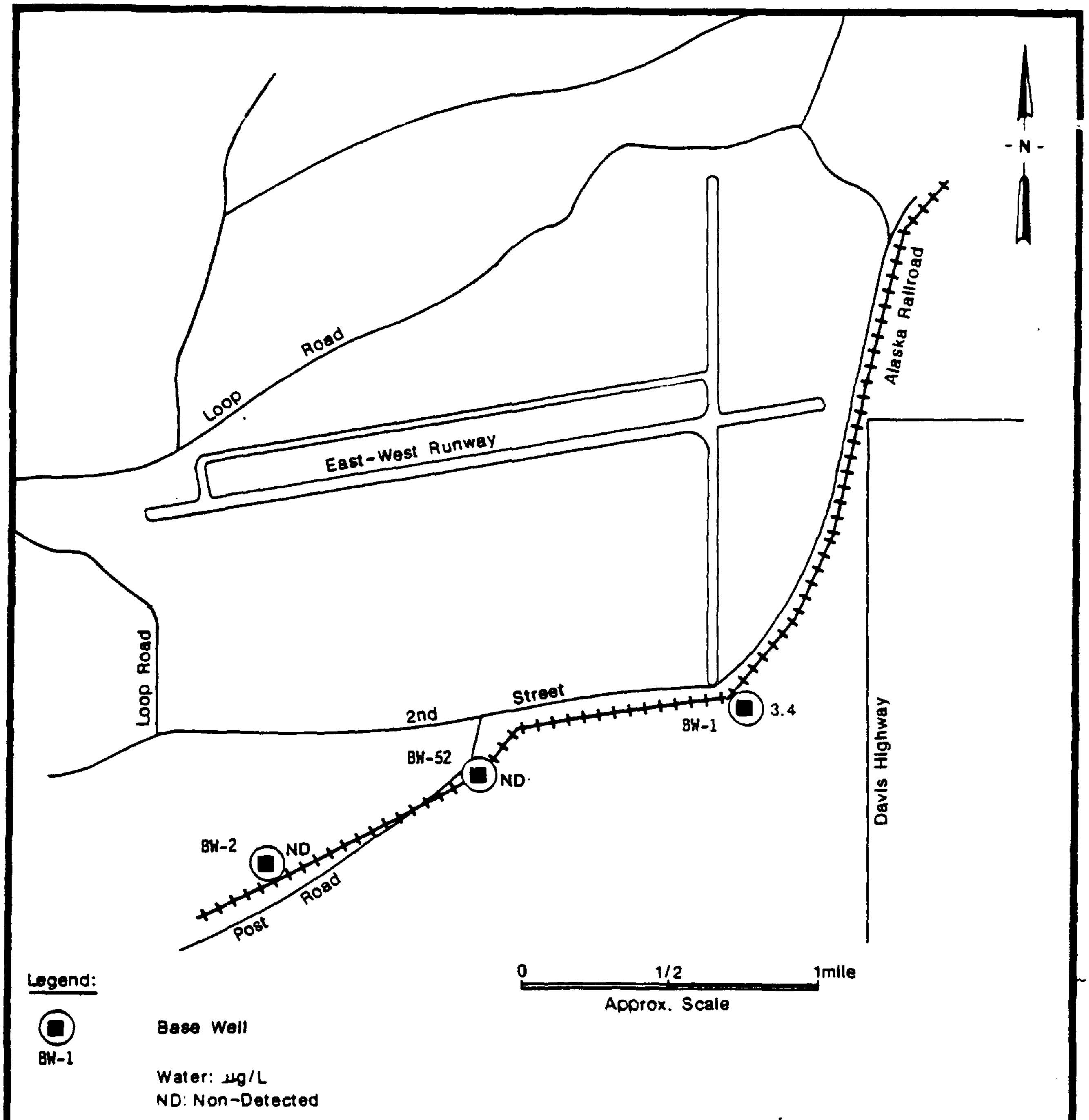
IRP Stage 3 RI/FS Elmendorf AFB, AK	Figure 4.2.24.2



TRICHLOROETHENE CONCENTRATION BASE WELLS 1, 2 & 52

IRP Stage 3 RI/FS
Elmendorf AFB, AK

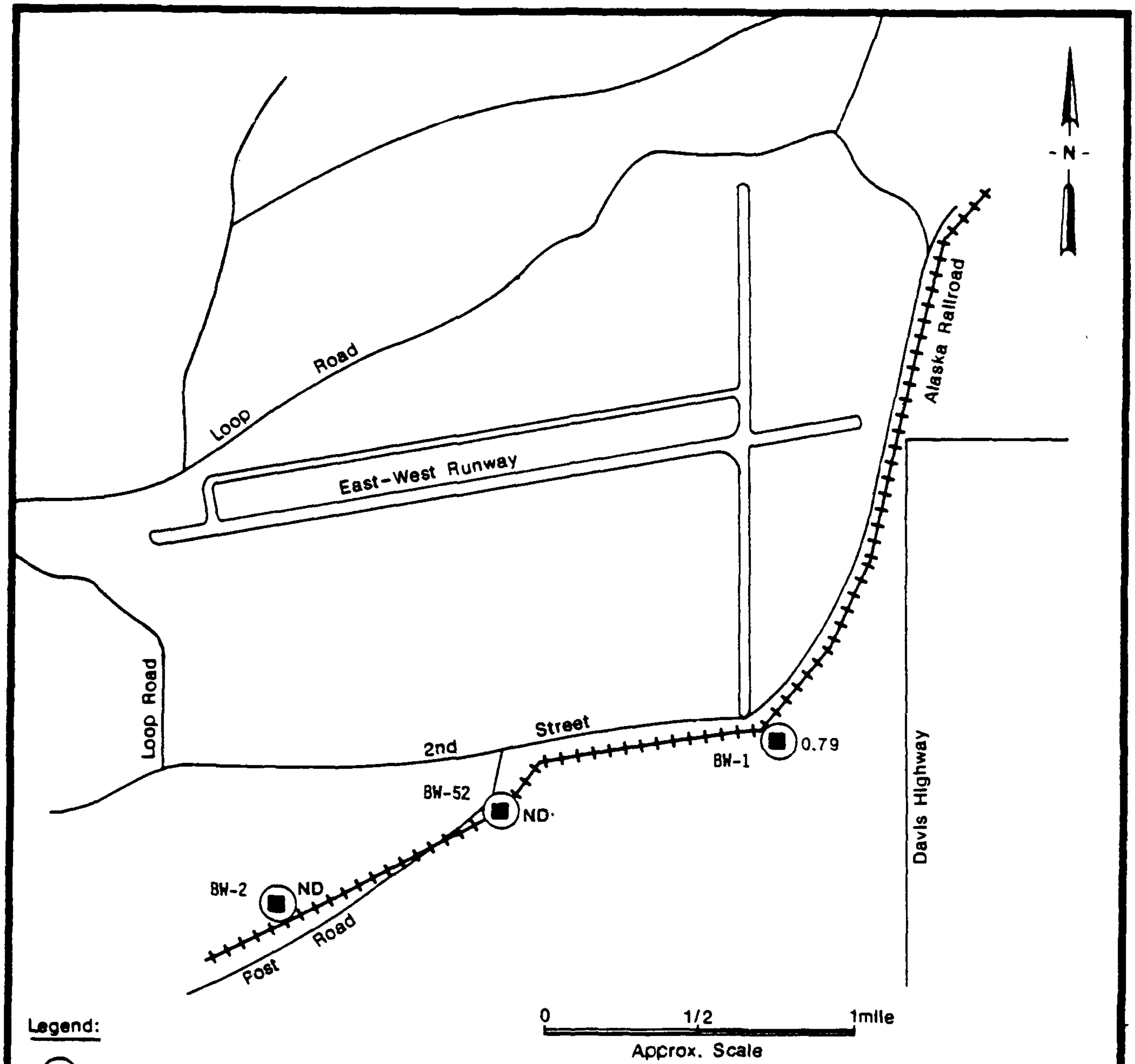
Figure 4.2.24.3



1,1,1-TRICHLOROETHANE CONCENTRATION BASE WELLS 1, 2 & 52

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.24.4



Legend:

Base Well

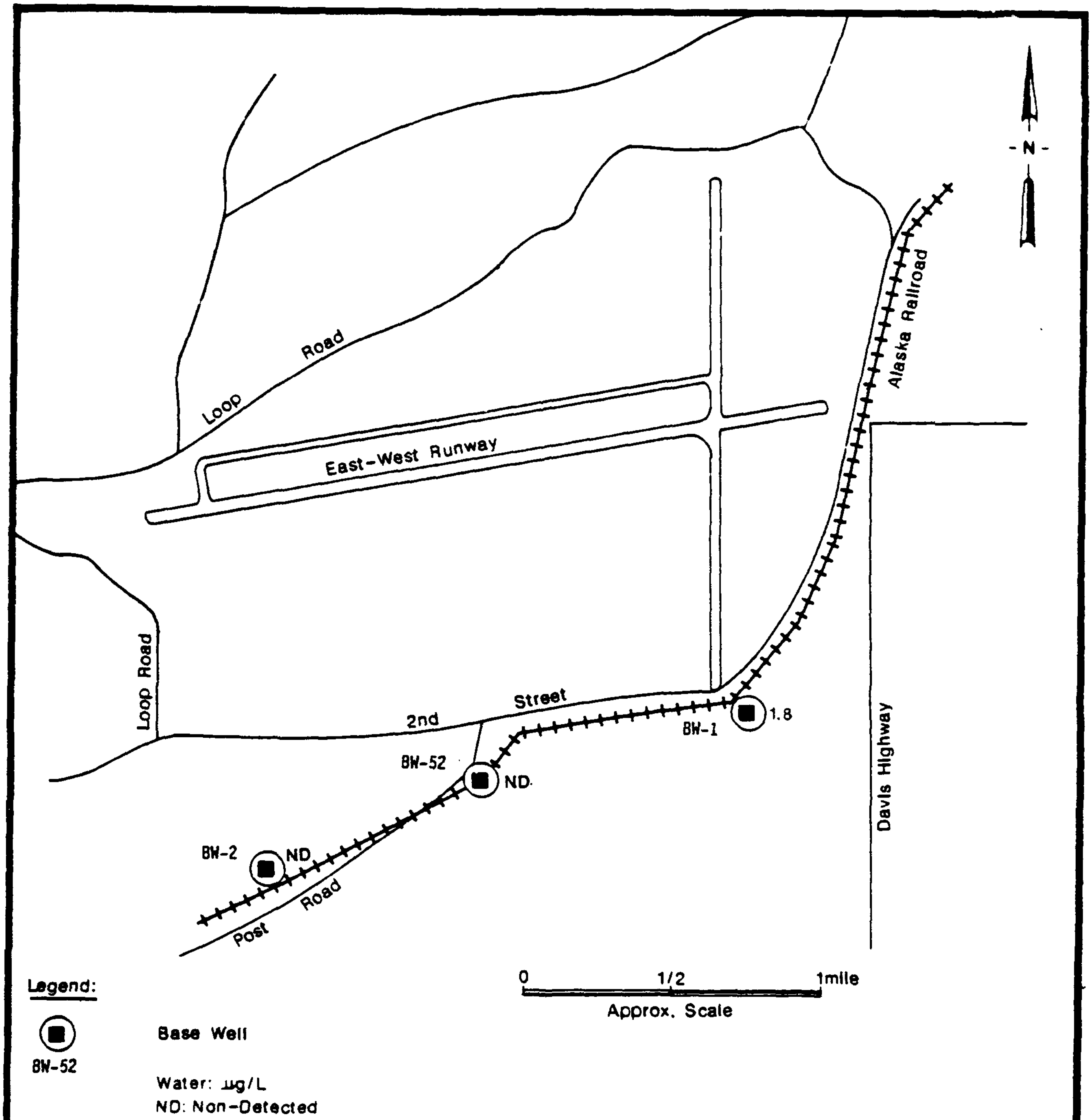
BW-2

Water: µg/L
ND: Non-Detected

1,1-DICHLOROETHANE
CONCENTRATION
BASE WELLS 1, 2 & 52

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.24.5



1,1,2,2 -TETRACHLOROETHANE CONCENTRATION BASE WELLS 1, 2 & 52

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.24.6

identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well. Results of analytical tests are presented on Table 4.2.24.3.

4.2.24.1.4 Analytical Results Table

All of the laboratory analytical results for the base wells are presented on Table 4.2.24.3.

4.2.24.1.5 Discussion of Analytical Data

Chlorinated hydrocarbon compounds were detected in a sample from 1 of the base water wells (Figures 4.2.24.3, through 4.2.24.6). The compounds 1,1-dichloroethane, 1,1,1-trichloroethane, trichloroethene, and 1,1,2,2,-tetrachloroethane were detected at concentrations of 0.79, 3.4, 1.4, and 1.8 ug/L, respectively, in a sample from BW-1, which draws from the shallow aquifer. This water sample also contained a total petroleum hydrocarbon concentration of 3.0 mg/L. Petroleum hydrocarbons (2.0 mg/L) were also detected in a water sample from BW-52.

Metals such as manganese (total: 0.019 to 0.060) and magnesium (total: 5.4 to 6.7 mg/L) were detected in water samples from the wells. However, a sample from base well BW-52 did not contain manganese.

Total calcium (.11 to 28 mg/L), total sodium (3.6 to 40 mg/L), sulfate (12 to 17 mg/L) and chloride ions (1.4 to 3.4 mg/L) were detected in water from the 3 base water wells.

Trace amounts of other elements such as barium, copper, arsenic, and zinc were detected in water samples from the site. Total barium (0.013 mg/L), copper (0.009 mg/L), and arsenic (0.005 mg/L) were detected in water from well BW-2. A sample from well W-1 contained total barium (0.007 mg/L) and zinc (0.01 mg/L). The water sample from BW-52 did not contain any of these elements.

Table 4.2.24.3

Analytical Results - Site BW-1

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	BW-1 0687-NG-117,GN-88-0001 001370-0007
1,1,1-Trichloroethane	EPA 601	ug/L	200	3.4
1,1,2,2-Tetrachloroethane	EPA 601	ug/L	0.17	1.8
1,1-Dichloroethane	EPA 601	ug/L		0.79
Aluminum	6010	mg/kg		
Arsenic	6010	mg/kg	0.42	
Barium	6010	mg/kg		
Beryllium	6010	mg/kg		
Calcium	6010	mg/kg		
Chloride	300.0	mg/L		3.4
Chromium	6010	mg/kg	50,000	
Cobalt	6010	mg/kg		
Copper	6010	mg/kg	1,850	
Dissolved Aluminum	200.7	mg/L		
Dissolved Barium	200.7	mg/L	1.0	0.008
Dissolved Calcium	200.7	mg/L		29.
Dissolved Iron	200.7	mg/L	0.3	
Dissolved Magnesium	200.7	mg/L		5.7
Dissolved Manganese	200.7	mg/L	0.05	0.060
Dissolved Sodium	200.7	mg/L	250	3.8
Dissolved Zinc	200.7	mg/L	5.0	0.02
Iron	6010	mg/kg		
Lead	6010	mg/kg	70	
Magnesium	6010	mg/kg		
Manganese	6010	mg/kg	11,000	
Molybdenum	6010	mg/kg		
Nickel	6010	mg/kg	500	
Potassium	6010	mg/kg		
Recoverable Aluminum	200.7	mg/L		
Recoverable Arsenic	206.2	mg/L	0.05	
Recoverable Barium	200.7	mg/L	1.0	0.007
Recoverable Beryllium	200.7	mg/L	0.0000039	
Recoverable Calcium	200.7	mg/L		28.
Recoverable Chromium	200.7	mg/L	0.05	
Recoverable Cobalt	200.7	mg/L		
Recoverable Copper	200.7	mg/L	1.0	
Recoverable Iron	200.7	mg/L	0.3	
Recoverable Lead	239.2	mg/L	0.05	
Recoverable Magnesium	200.7	mg/L		5.4
Recoverable Manganese	200.7	mg/L	0.05	0.060
Recoverable Molybdenum	200.7	mg/L		
Recoverable Nickel	200.7	mg/L		
Recoverable Potassium	200.7	mg/L		
Recoverable Sodium	200.7	mg/L	250	3.6
Recoverable Vanadium	200.7	mg/L		
Recoverable Zinc	200.7	mg/L	5.0	0.01
Silver	6010	mg/kg		
Sodium	6010	mg/kg		
Sulfate	300.0	mg/L	250	17.
Total Mercury	245.1	mg/L	0.002	
Total Petroleum Hydrocarbons	EPA 418.1			3.0
Total Solids	160.3	%		
Trichloroethene	EPA 601	ug/L	5.0	1.4
Vanadium	6010	mg/kg	1,000	
Zinc	6010	mg/kg	10,500	

Table 4.2.24.3

Analytical Results - Site BW-2

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	BW-2 0687-NG-125,GW-88-0001 001370-0009
Aluminum	6010	mg/kg		
Arsenic	6010	mg/kg	0.42	
Barium	6010	mg/kg		
Beryllium	6010	mg/kg		
Calcium	6010	mg/kg		
Chloride	300.0	mg/L	250	2.4
Chromium	6010	mg/kg	50,000	
Cobalt	6010	mg/kg		
Copper	6010	mg/kg	1,850	
Dissolved Arsenic	206.2	mg/L	0.05	0.005
Dissolved Barium	200.7	mg/L	1.0	0.013
Dissolved Calcium	200.7	mg/L		11.
Dissolved Copper	200.7	mg/L	1.0	0.006
Dissolved Magnesium	200.7	mg/L		5.9
Dissolved Manganese	200.7	mg/L	0.05	0.018
Dissolved Sodium	200.7	mg/L	250	41.
Iron	6010	mg/kg		
Lead	6010	mg/kg	70	
Magnesium	6010	mg/kg		
Manganese	6010	mg/kg	11,000	
Molybdenum	6010	mg/kg		
Nickel	6010	mg/kg	500	
Potassium	6010	mg/kg		
Recoverable Arsenic	206.2	mg/L	0.05	0.005
Recoverable Barium	200.7	mg/L	1.0	0.013
Recoverable Calcium	200.7	mg/L		10.
Recoverable Copper	200.7	mg/L	1.0	0.009
Recoverable Magnesium	200.7	mg/L		5.7
Recoverable Manganese	200.7	mg/L	0.05	0.019
Recoverable Sodium	200.7	mg/L	250	40.
Sodium	6010	mg/kg		
Sulfate	300.0	mg/L		16.
Total Solids	160.3	%		
Vanadium	6010	mg/kg	1,000	
Zinc	6010	mg/kg	10,500	

Table 4.2.24.3

Analytical Results - Site BW-52

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	BW-52 TRIP BLANK	BW-52 0687-NG-118,GN-88-0001 001370-0010	BW-52 DUPLICATE 0687-NG-118,GN-88-0001D 001370-0010	BW-1 BW-1/36	BW-1 BW-1/38	BW-2 BW-2/39	BW-52 BW-52/37	BW-52 BW-52/40
1,1,1-TRICHLOROETHANE	601	ug/L	200				0.63				
CHLOROFORM	601	ug/L	100							1.2	
Chloride	300.0	mg/L	250		1.4	1.4					
Dissolved Calcium	200.7	mg/L			27.	27.					
Dissolved Magnesium	200.7	mg/L			7.1	7.0					
Dissolved Sodium	200.7	mg/L	250		6.5	6.9					
METHYLENE CHLORIDE	601	ug/L		32			3.7				
Recoverable Calcium	200.7	mg/L			26.	26.					
Recoverable Magnesium	200.7	mg/L			6.7	6.7					
Recoverable Sodium	200.7	mg/L	250		6.4	6.7					
Sulfate	300.0	mg/L	250		12.	12.					
TETRACHLOROETHENE	601	ug/L	5				0.77				
TRICHLOROETHENE (TCE)	601	ug/L	5				1.2				
TRICHLOROFLUOROMETHANE	601	ug/L		0.94			0.83				
Total Dissolved Solids	160.1	mg/L				130.		130	110		140
Total Petroleum Hydrocarbons	EPA 418.1	mg/L			2.0	0.5					

4.2.24.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at the base water wells include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.24.2.1 Loss of Samples

No water samples collected for laboratory analysis were lost from the base water wells.

4.2.24.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is unlikely that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (see Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (see Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. No compounds commonly associated with laboratory procedures were detected in samples from the wells.

4.2.24.2.3 Analytical Results Obtained Under Out-of-Control Conditions

One water sample was collected from each of 3 base water wells. No out-of-control conditions occurred during sampling operations.

4.2.25 Results for the Basewide Hydrogeology Sites

Five monitoring wells and 1 test boring were installed to obtain information concerning the basewide hydrogeological system. These sites are not IRP sites.

4.2.25.1 Presentation of Results at the Base Water Wells at BH 1-6

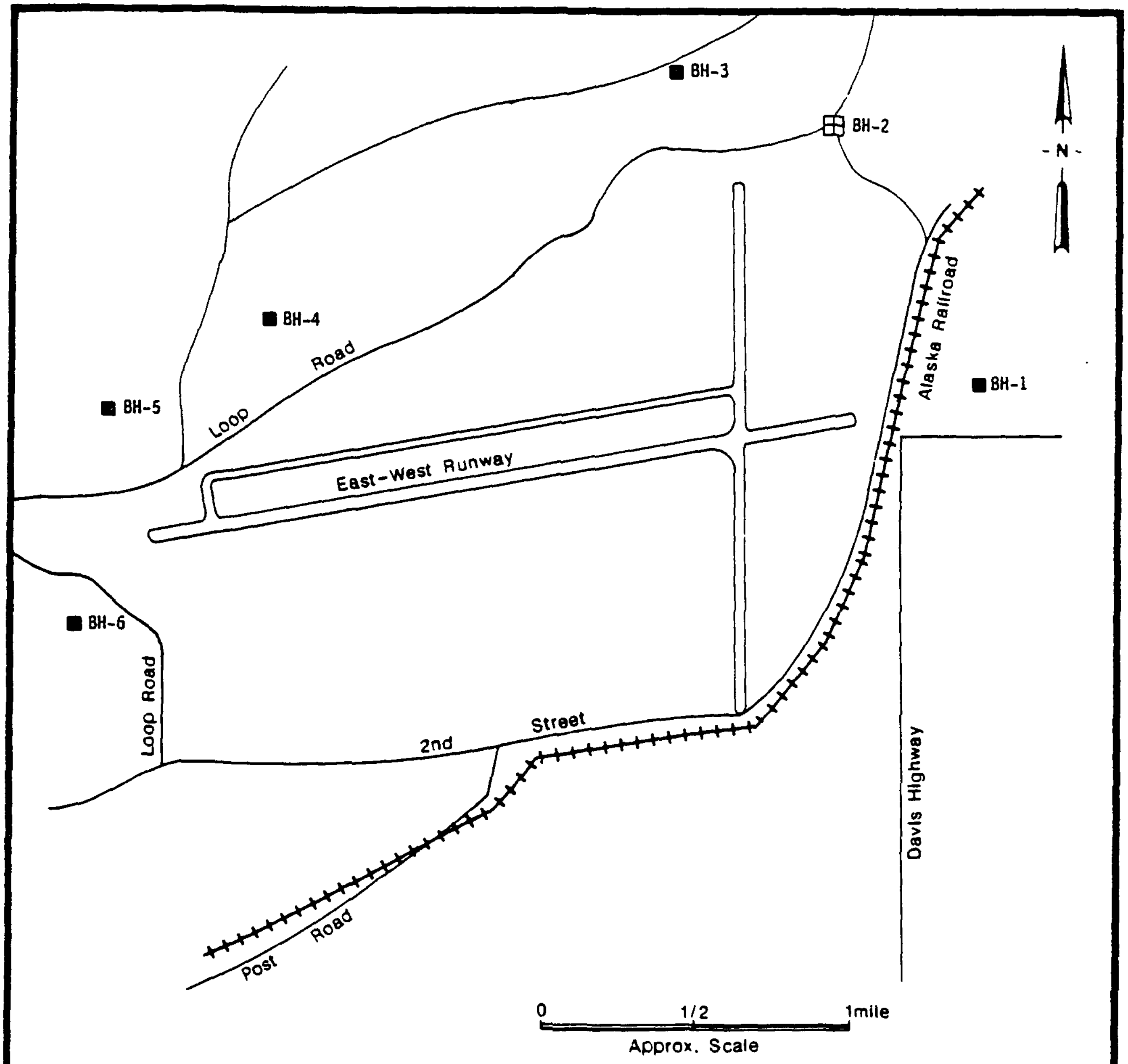
Results of the geologic and hydrogeologic investigations are presented below. In addition, analytical results are tabulated and presented on the site maps.

4.2.25.1.1 Site Geology for Basewide Hydrogeology Wells

Knowledge of basewide hydrogeology was augmented by drilling 6 borings, all but 1 of which were completed as monitoring wells on Elmendorf AFB in areas where little or no previous subsurface investigations had been conducted. The location of these wells and borings is shown in Figure 4.2.25.1. In addition, a detailed site map is also provided for each boring in Figures 4.2.25.2 through 4.2.25.7. Logs of the wells and borings are provided in Appendix C. The following is a discussion of the geology of the borehole and each well site:

o BH-1

BH-1 is located in late Quaternary glacial outwash deposits at an elevation of 230 feet. The site surface is fairly flat and located at the edge of a gravel road bisecting a zone of spruce/birch forest. Sediments are generally coarse sands and gravels with some silt. An interpreted gamma log is provided in Appendix D. Hydraulic conductivity values have not yet been established for this site.



Legend:

BH-1 ■ Monitoring Well Location Stage 3

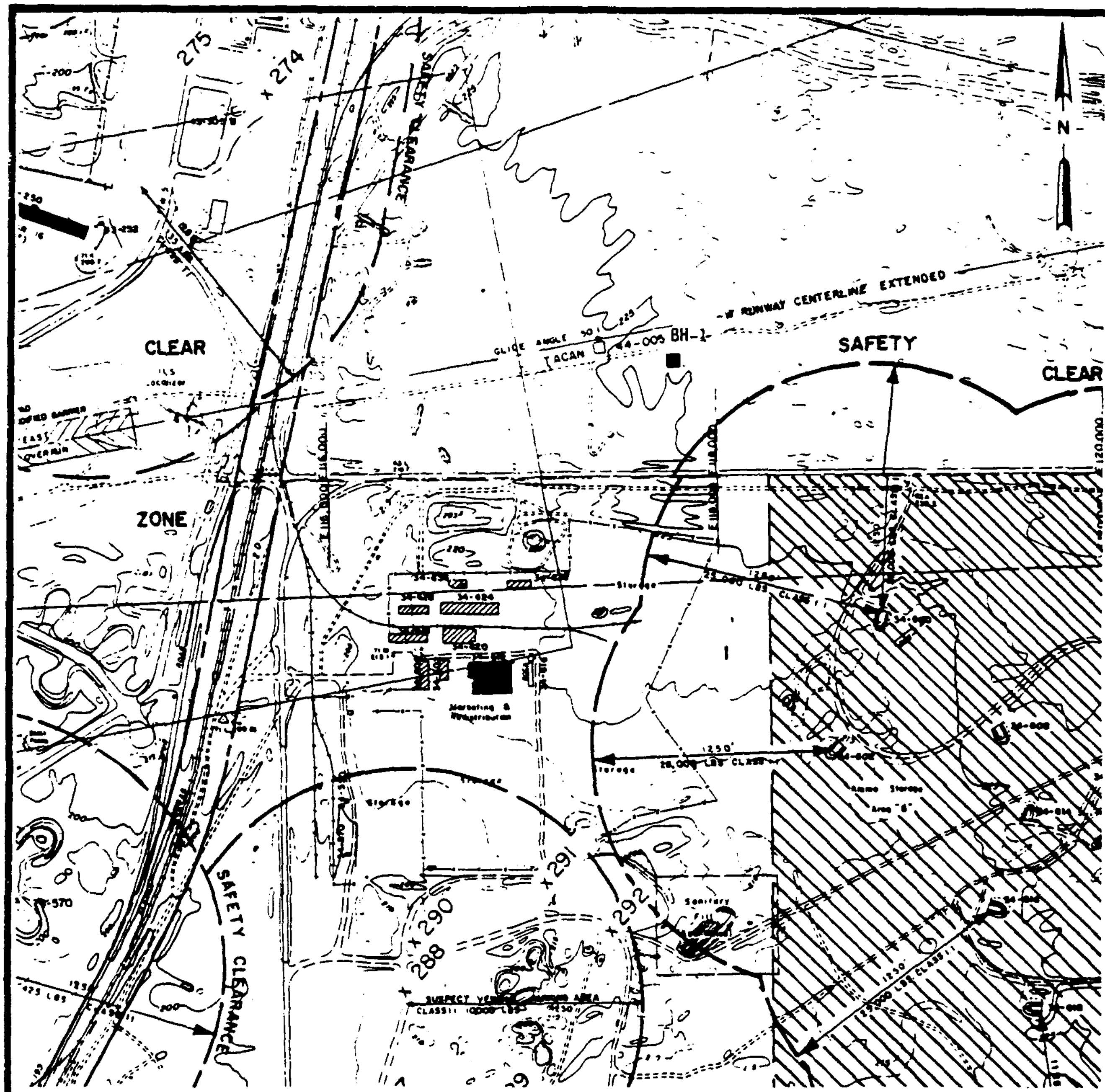
BH-2 ⊞ Stage 3 Borehole

+++++++++ Railroad

LOCATION MAP
BASEWIDE HYDROGEOLOGY WELLS

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.25.1



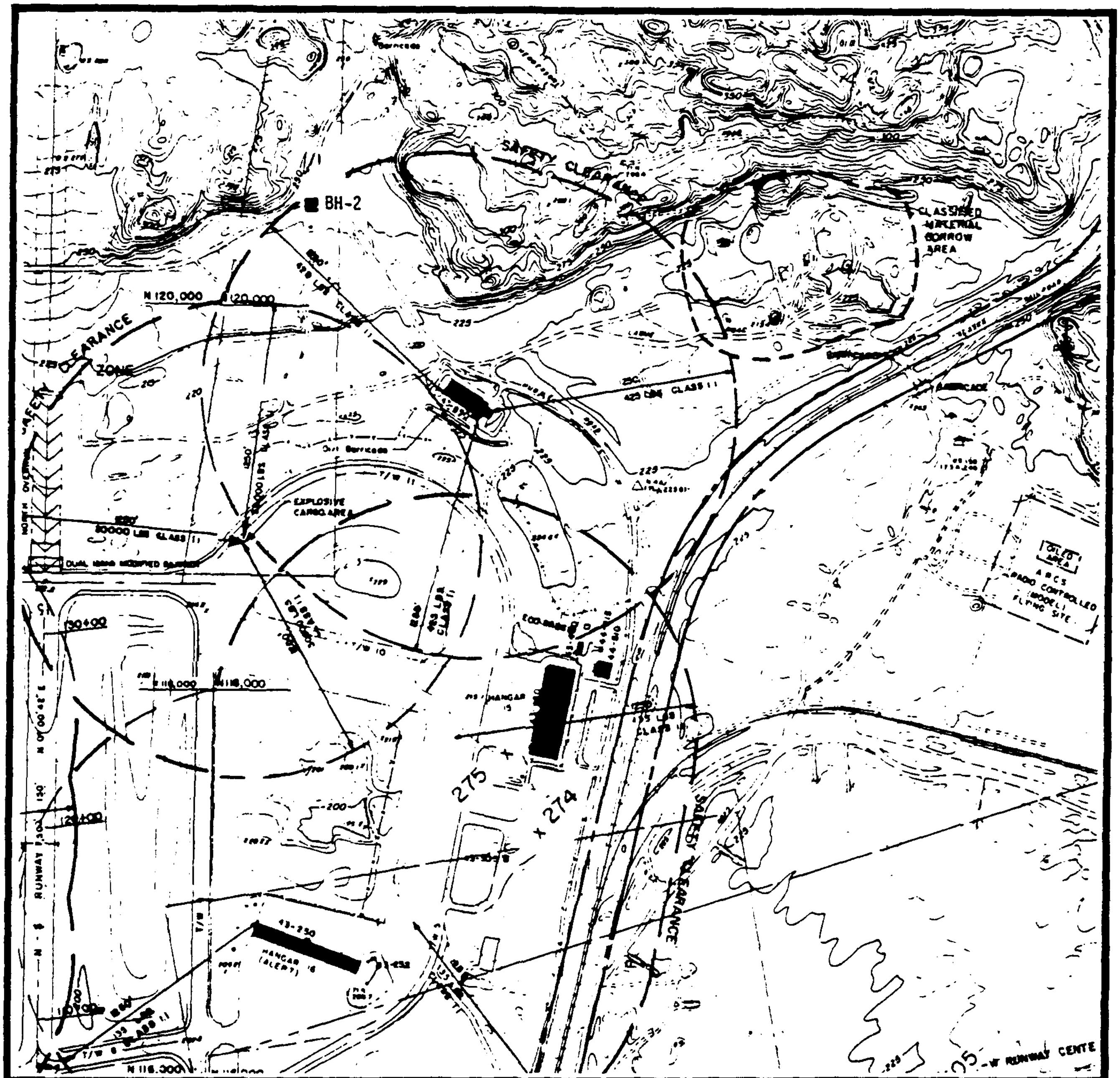
Legend:

BH-1 ■ Monitoring Well Location Stage 3

DETAIL SITE MAP
SITE 1
BASEWIDE HYDROGEOLOGY WELLS

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.25.2



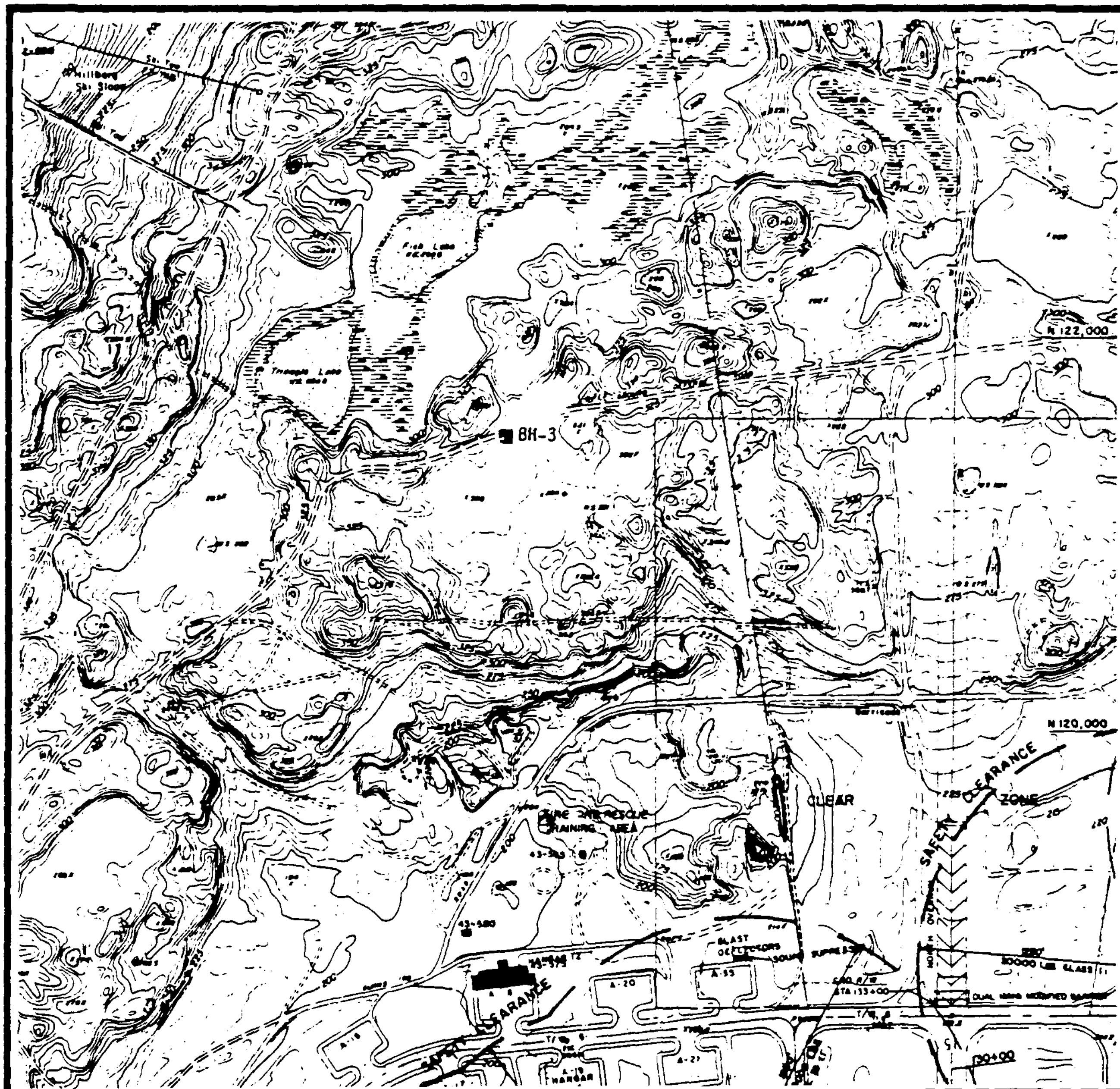
Legend:

BH-2 ■ Monitoring Well Location Stage 3

DETAIL SITE MAP
SITE 2
BASEWIDE HYDROGEOLOGY WELLS

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.25.3



Legend:

BH-3 ■ Monitoring Well Location Stage 3

0 800 1600ft

Scale

-N-

DETAIL SITE MAP
SITE 3
BASEWIDE HYDROGEOLOGY WELLS

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.25.4

0 800 1600ft
Scale

N

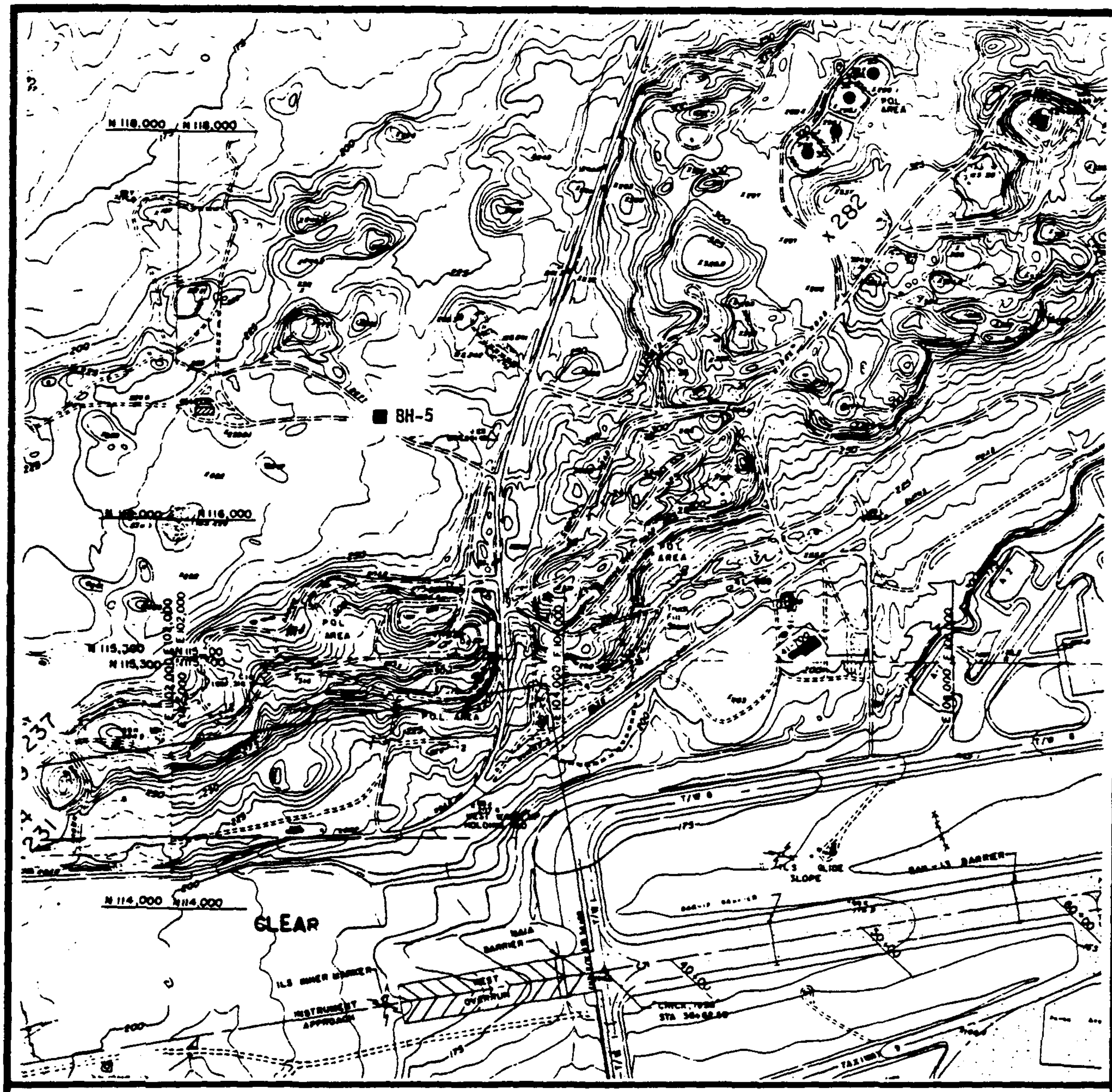
Legend:

BH-4 ■ Monitoring Well Location Stage 3

DETAIL SITE MAP
SITE 4
BASEWIDE HYDROGEOLOGY WELLS

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.25.5



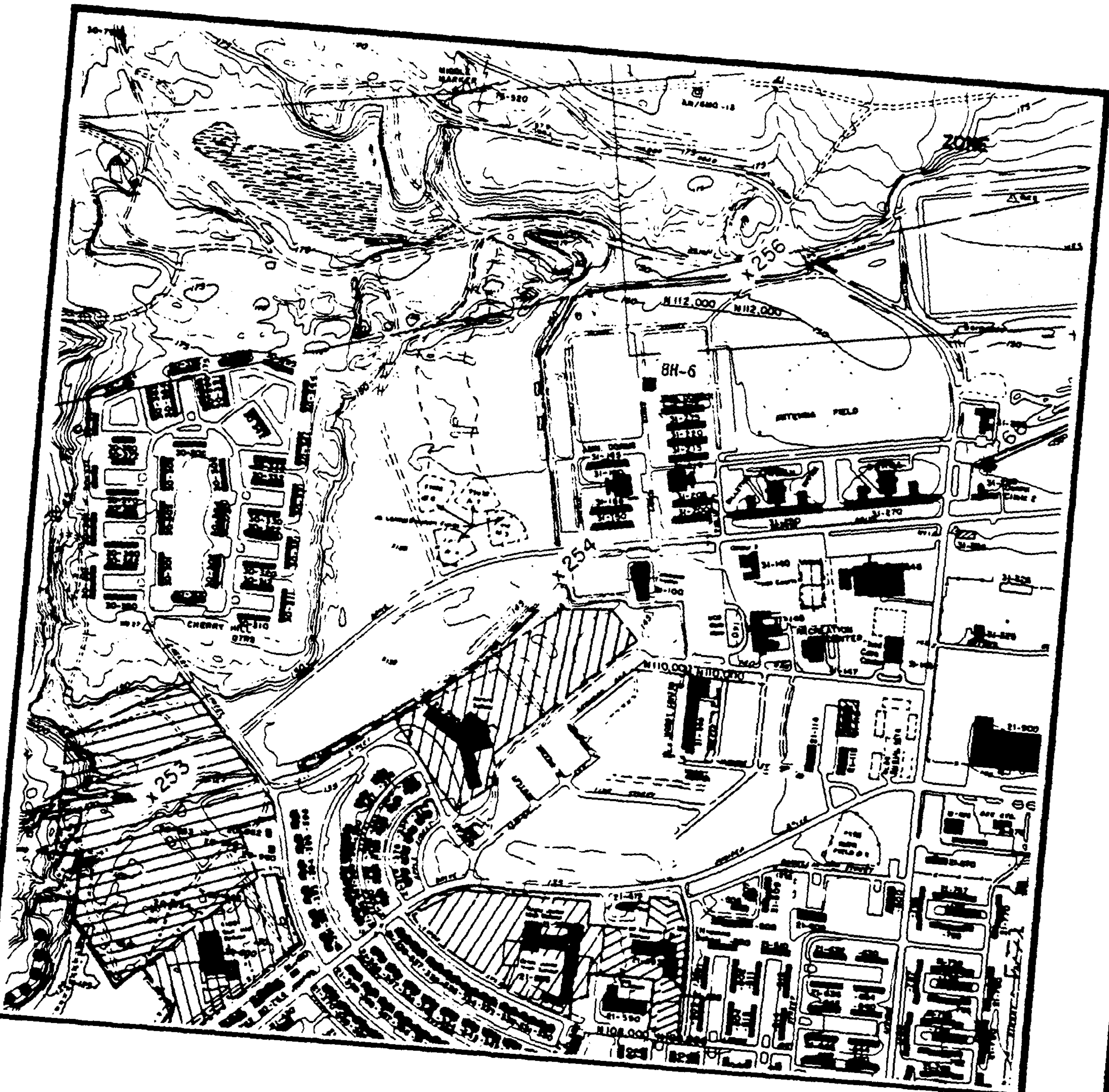
Legend:

BH-5 ■ Monitoring Well Location Stage 3

DETAIL SITE MAP
SITE 5
BASEWIDE HYDROGEOLOGY WELLS

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.25.6



Legend:

8H-6 ■ Monitoring Well Location Stage 3

0 800 1600ft

Scale

- N -

DETAIL SITE MAP
SITE 6
BASEWIDE HYDROGEOLOGY WELLS

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure
4.2.25.7

- BH-2

BH-2 is located in moderately hilly terrain at an elevation of 249 feet. The site is located at the south edge of the Elmendorf Moraine at the center of a 3-way road intersection. The site is underlain by coarse alluvial sediments to a depth of about 8 feet. Coarse glacial till consisting of silty sand and gravel predominates below the alluvium. Spruce and birch forest occupying natural terrain borders the roads at the site. The water table was not encountered in the boring which was drilled to a depth of 60 feet.

- BH-3

BH-3 is located in hummocky terrain of the Elmendorf Moraine at an elevation of 318 feet. The site is situated amid several shallow ponds and mounds resulting from kame and kettle type glacial topography. Till underlying the site is composed of a heterogeneous mixture of silt, sand, gravel, cobbles and boulders (till) with some localized zones of sorted sediments. The site is well vegetated with spruce and birch forest occupying higher ground and sedges and grasses in low-lying areas.

Hydraulic conductivity was calculated at 3.3×10^{-2} feet per day from results of a slug test.

- BH-4

BH-4 is located in hilly terrain of the Elmendorf Moraine at an elevation of 303 feet. The site is situated adjacent to an

access road to a POL tank farm and near the edge of a pond. The site is underlain by till common to moraine deposits. Some zones in the till have been sorted due to ice-marginal processes. An interpreted gamma log of the boring is provided in Appendix D. Surrounding vegetation consists of spruce and birch forest on elevated areas and grass and sedges in low-lying areas.

A hydraulic conductivity of 5.4 feet per day was calculated from results of a slug test.

- BH-5

BH-5 is located in hilly terrain on the Elmendorf Moraine at an elevation of 245 feet. The site is situated adjacent to a gravel access road. The site is underlain by till common to this landform. Surrounding vegetation includes spruce and birch forest in elevated areas and tall grass in low lying areas.

A hydraulic conductivity of 1.9 feet per day was calculated from results of a slug test.

- BH-6

Well BH-6 is located on fairly flat terrain at an elevation of 145 feet. The site had been previously cleared and graded. The site is underlain by late-Quaternary glacial outwash consisting chiefly of coarse sands and gravel with some silt. The surficial alluvium is underlain at about the 10 feet depth by fine-grained sediments of the Bootlegger Cove Formation. An interpreted gamma log of the boring is provided in Appendix D. Hydraulic conductivity values have not yet been estalbished for this site.

4.2.25.1.2 Basewide Hydrogeology

Elmendorf AFB is situated on the north side of the Anchorage lowlands, a low to moderate relief glaciated terrain. Glacial sediments overlie indurated rocks at a depth of at least several hundred feet. Four distinctive shallow hydrogeologic environments are recognizable on Elmendorf AFB: the alluvial plain underlying the main runways and most of the developed areas of the base; the Ship Creek valley, occurring along the southern border of the base; the Elmendorf Moraine, encompassing most of the hilly land north of Burns and Ladue Roads; and the Cherry Hill area, generally west and southwest of the east-west runway and west ramp. Underlying all 4 of these environments are confined sand and gravel aquifers. These aquifers are widely utilized for water supplies, both on- and off-Base.

The alluvial plain underlying the main part of the base is a gently sloping glacial outwash plain composed predominantly of gravels and sands. The alluvial deposits are thin or absent in the Cherry Hill area and thicken to about 125 feet near the east boundary of Elmendorf AFB. They are underlain by silts and clays of the Bootlegger Cove Formation.

The Ship Creek valley is incised approximately 20 to 100 feet into the alluvial plain in a steep-walled valley about 2000 feet wide. The Ship Creek valley contains alluvial sands and gravels ranging in thickness from only a few feet in the lower reaches where Ship Creek is incised into the Bootlegger Cove Formation, to about 50 feet near the east boundary of Elmendorf AFB. The Bootlegger Cove Formation

underlies both the alluvial plain and the Ship Creek valley at least as far east as the east boundary of Elmendorf AFB.

The Elmendorf Moraine is a terminal moraine of the Knik-Matanuska glacial lobe which retreated during the Wisconsinan glacial epoch. The moraine is composed predominantly of poorly sorted till, non sorted sand size and larger particles dispersed through a fine grained matrix of silts and clay, called till. Locally, glacioalluvial deposits consisting of sand or sand and gravel also occur within the morainal deposits, and constitute the main water-transmitting units.

The Cherry Hill area generally west and southwest of the east-west runway and the west ramp is underlain predominantly by silts and clays of the Bootlegger Cove Formation at shallow depths. Since much of this area is topographically flat, original drainage was probably poor with numerous areas of water-saturated soil. Existing drainage of the area by the Cherry Hill Ditch and its tributaries has probably contributed to an area-wide lowering of the water table.

A major groundwater divide occurs along the crest of the southwest part of the Elmendorf Moraine near Ridge Road. The divide passes to the north of Triangle and Fish Lakes, and crosses the Alaska Railroad tracks about 1000 feet north of their ascent onto the Elmendorf Moraine. North of the divide groundwater flows generally towards Knik Arm and Sixmile Lake, and south of the divide, groundwater flows toward Ship Creek. Regionally, groundwater flow on the moraine is generally perpendicular to the long axis of the moraine. Locally, highly irregular groundwater flow resulting from the kame and kettle topography and heterogeneous geologic deposits is expected to occur.

The pattern of groundwater flow in the alluvial plain is highly influenced by Ship Creek. East of the Davis Highway bridge, Ship Creek loses water to the shallow aquifer and groundwater flows

northwesterly away from the creek. Near the Davis Highway and Hubble Road, groundwater in the alluvial plain flows essentially east to west. West of the Davis Highway shallow groundwater flows southwesterly to southerly, ultimately discharging to Ship Creek. Groundwater in the Cherry Hill area also flows southward discharging to Ship Creek, except near the Knik Arm bluff, when it discharges to Knik Arm through small gullies and drainages.

Throughout the base except in the Ship Creek valley, some groundwater flows vertically through the Bootlegger Cove Formation to underlying confined sand and gravel aquifers. Some deep wells are reported to be artesian, and they flow in the Ship Creek valley from confined aquifers. Because water levels in these confined aquifers are influenced by pumpage from water-supply wells through north Anchorage, the exact flow regime currently occurring in the confined aquifers is unknown.

4.2.25.1.3 Analytical Results

Field analytical results and observations and laboratory analytical results are discussed in the following sections.

4.2.25.1.3.1 Field Analytical Results and Observations

At several of the boring and well locations there were no indications of contamination either as stains, odor, or HNu readings. These locations included BH-2 and wells BH-3, BH-4 and BH-6.

Locations where evidence of contamination was observed includes the following:

o BH-1 - HNu readings of 5 ppm at the 5 feet depth and 1 ppm at 10 feet depth were recorded.

- o BH-5 - HNu readings of 5 ppm at the 2 feet depth and 7 ppm at the 11 feet depth were recorded.

Field parameters measured at these well locations during groundwater sampling are listed on Table 4.2.25.1.

Table 4.2.25.1 Field Parameters BH Wells

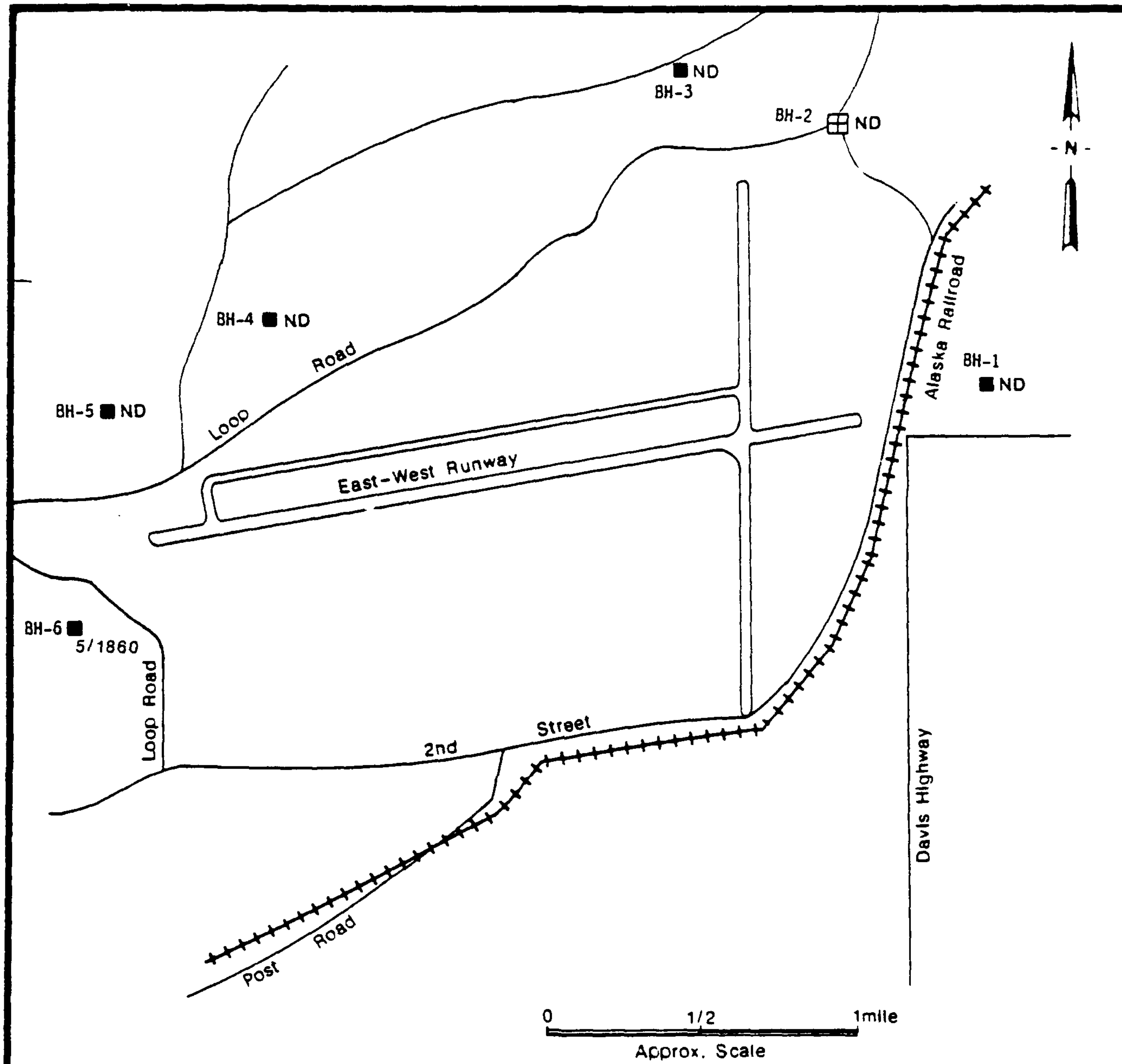
Well Number	Date Sampled	Temperature (C)	Conductivity (umhos/cm)	pH	Alkalinity mg/L	Appearance
BH-1	8/30/88	5.2	95	7.00	45	No odor or sheen
BH-3	8/30/88	5.5	705	7.49	105	No odor or sheen
BH-4	8/30/88	6.5	98	6.32	45	No odor or sheen
BH-5	8/30/88	7.5	338	6.42	170	No odor or sheen
BH-6	8/30/88	11.5	372	6.39	170	No odor or sheen

4.2.25.1.3.2 Laboratory Analytical Results

The laboratory analytical program for the basewide hydrology wells is presented on Table 4.2.25.2, and the sample plan for the base-wide field investigation program is included in Appendix B. Major organic contaminants identified from the laboratory analysis of samples collected at the basewide hydrogeologic wells are plotted in Figures 4.2.25.8 and 4.2.25.9. A separate map for each identified hydrocarbon contaminant is provided; the analyte concentrations are plotted next to the corresponding well or test boring. Results of analytical tests are presented on Table 4.2.25.3.

4.2.25.1.4 Analytical Results Table

All of the laboratory analytical results for detected parameters at the basewide hydrogeology wells are presented on Table 4.2.25.3.



Legend:

BH-1 ■ Monitoring Well Location Stage 3

BH-2 ⊞ Stage 3 Borehole

Railroad

Well Number

Well Location

Depth of Sample (ft)

Analyte Concentration

BH-3 (Symbol) 10/300

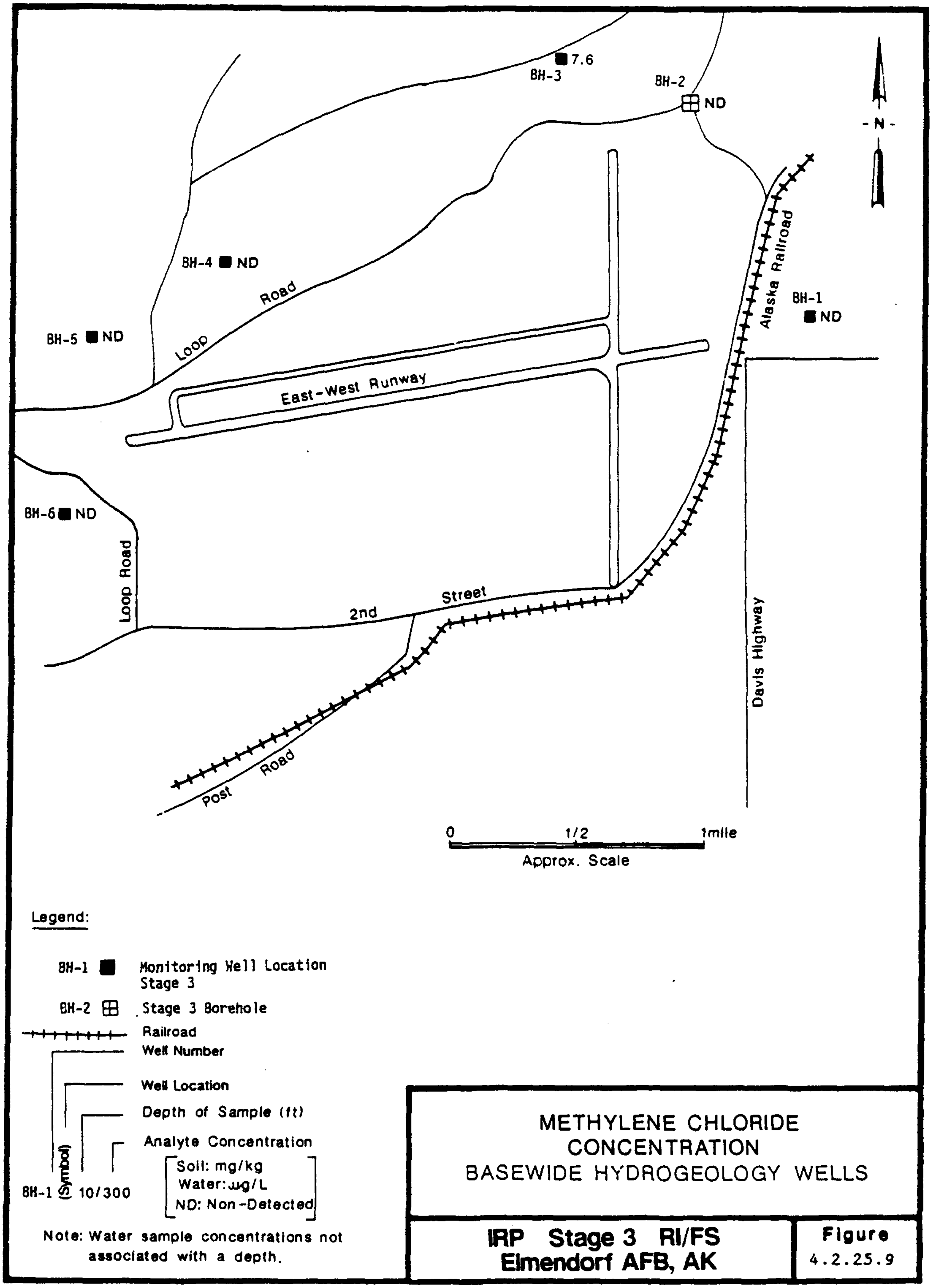
[Soil: mg/kg
Water: mg/L
ND: Non-Detected]

Note: Water sample concentrations not associated with a depth.

TOTAL PETROLEUM HYDROCARBON CONCENTRATION
BASEWIDE HYDROGEOLOGY WELLS

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.25.8



METHYLENE CHLORIDE CONCENTRATION
BASEWIDE HYDROGEOLOGY WELLS

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.25.9

Table 4.2.25.2 Requested Analyses for Laboratory Samples at Basewide Hydrogeology Wells

SOIL/SEDIMENT

Test Number	Analysis
3550	Total Petroleum Hydrocarbons
6010	ICP Screen (25 metals)
7471	Mercury
8240	Volatile Organic Compounds
8270	Semi-volatile Organic Compounds
160.3	Soil Moisture Content

WATER

Test Number	Analysis
300	Common Anions
418.1	Petroleum Hydrocarbons
200.7	ICP Screen (total and dissolved)
206.2	Arsenic (total and dissolved)
239.2	Lead (total and dissolved)
245.1	Mercury (total dissolved)
270.2	Selenium (total and dissolved)
601	Purgeable Halocarbons
602	Purgeable Aromatics
625	Extractable Priority Pollutants

Table 4.2.25.3

Analytical Results - Site BH-1

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	BH-1 0687-NG-119,GN-88-0003 001452-0009	BH-1 0687-SO-119 GS-88-0001 001240-0003
1,1,1-Trichloroethane	EPA 601	ug/L	200		
1,1,2,2-Tetrachloroethane	EPA 601	ug/L	0.17		
1,1-Dichloroethane	EPA 601	ug/L			
Aluminum	6010	mg/kg			12900
Arsenic	6010	mg/kg	0.42		11
Barium	6010	mg/kg			45
Beryllium	6010	mg/kg			0.3
Calcium	6010	mg/kg			4371
Chloride	300.0	mg/L			
Chromium	6010	mg/kg	50,000		30
Cobalt	6010	mg/kg			13
Copper	6010	mg/kg	1,850		34
Dissolved Aluminum	200.7	mg/L		0.23	
Dissolved Barium	200.7	mg/L	1.0	0.044	
Dissolved Calcium	200.7	mg/L		24.	
Dissolved Iron	200.7	mg/L	0.3	0.25	
Dissolved Magnesium	200.7	mg/L		3.7	
Dissolved Manganese	200.7	mg/L	0.05	0.036	
Dissolved Sodium	200.7	mg/L	250	11.	
Dissolved Zinc	200.7	mg/L	5.0		
Iron	6010	mg/kg			31237
Lead	6010	mg/kg	70		13
Magnesium	6010	mg/kg			10128
Manganese	6010	mg/kg	11,000		650
Molybdenum	6010	mg/kg			7
Nickel	6010	mg/kg	500		35
Potassium	6010	mg/kg			746
Recoverable Aluminum	200.7	mg/L		101.	
Recoverable Arsenic	206.2	mg/L	0.05	0.005	
Recoverable Barium	200.7	mg/L	1.0	0.75	
Recoverable Beryllium	200.7	mg/L	0.0000039	0.003	
Recoverable Calcium	200.7	mg/L		72.	
Recoverable Chromium	200.7	mg/L	0.05	0.21	
Recoverable Cobalt	200.7	mg/L		0.17	
Recoverable Copper	200.7	mg/L	1.0	0.53	
Recoverable Iron	200.7	mg/L	0.3	236.	
Recoverable Lead	239.2	mg/L	0.05	0.075	
Recoverable Magnesium	200.7	mg/L		67.	
Recoverable Manganese	200.7	mg/L	0.05	9.3	
Recoverable Molybdenum	200.7	mg/L		0.06	
Recoverable Nickel	200.7	mg/L		0.40	
Recoverable Potassium	200.7	mg/L		6.	
Recoverable Sodium	200.7	mg/L	250	6.2	
Recoverable Vanadium	200.7	mg/L		0.32	
Recoverable Zinc	200.7	mg/L	5.0	0.49	
Silver	6010	mg/kg			4.4
Sodium	6010	mg/kg			107
Sulfate	300.0	mg/L	250		
Total Mercury	245.1	mg/L	0.002	0.0016	
Total Petroleum Hydrocarbons	EPA 418.1				
Total Solids	160.3	%			93.8
Trichloroethene	EPA 601	ug/L	5.0		
Vanadium	6010	mg/kg	1,000		46
Zinc	6010	mg/kg	10,500		58

Table 4.2.25.3

Analytical Results - Site BH-2

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	BH-2 5'-6.5' 0687-SO-120 GS-88-0001 001120-0003	BH-2 40'-41.5' 0687-SO-120 GS-88-0002 001120-0004	BH-2 60'-61.5' 0687-SO-119 GS-88-0002 001240-0004
Aluminum	6010	mg/kg		13319	10846	12216
Arsenic	6010	mg/kg	0.42			11
Barium	6010	mg/kg		51	36	49
Beryllium	6010	mg/kg		0.3	0.2	0.3
Calcium	6010	mg/kg		3911	4447	7892
Chloride	300.0	mg/L	250			
Chromium	6010	mg/kg	50,000	19	21	37
Cobalt	6010	mg/kg		8	9	12
Copper	6010	mg/kg	1,850	22	21	25
Dissolved Arsenic	206.2	mg/L	0.05			
Dissolved Barium	200.7	mg/L	1.0			
Dissolved Calcium	200.7	mg/L				
Dissolved Copper	200.7	mg/L	1.0			
Dissolved Magnesium	200.7	mg/L				
Dissolved Manganese	200.7	mg/L	0.05			
Dissolved Sodium	200.7	mg/L	250			
Iron	6010	mg/kg		22304	22560	37189
Lead	6010	mg/kg	70			12
Magnesium	6010	mg/kg		6237	7701	10378
Manganese	6010	mg/kg	11,000	497	466	681
Molybdenum	6010	mg/kg				10
Nickel	6010	mg/kg	500	18	26	35
Potassium	6010	mg/kg				757
Recoverable Arsenic	206.2	mg/L	0.05			
Recoverable Barium	200.7	mg/L	1.0			
Recoverable Calcium	200.7	mg/L				
Recoverable Copper	200.7	mg/L	1.0			
Recoverable Magnesium	200.7	mg/L				
Recoverable Manganese	200.7	mg/L	0.05			
Recoverable Sodium	200.7	mg/L	250			
Sodium	6010	mg/kg		95	108	151
Sulfate	300.0	mg/L				
Total Solids	160.3	%		94.6	92.2	92.5
Vanadium	6010	mg/kg	1,000	44	40	52
Zinc	6010	mg/kg	10,500	48	46	53

Analytical Results - Site BH-3

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	BH-3 0687-NG-121,GN-88-0002 001452-0004	BH-3 10'-11.5' 0687-SO-121 GS-88-0001 001324-0017
Aluminum	6010	mg/kg			12267
Barium	6010	mg/kg			50
Beryllium	6010	mg/kg			0.2
Calcium	6010	mg/kg			4162
Chromium	6010	mg/kg	50,000		26
Cobalt	6010	mg/kg			9
Copper	6010	mg/kg	1,850		26
Dissolved Barium	200.7	mg/L	1.0	0.055	
Dissolved Calcium	200.7	mg/L		78.	
Dissolved Magnesium	200.7	mg/L		24.	
Dissolved Manganese	200.7	mg/L	0.05	0.92	
Dissolved Molybdenum	200.7	mg/L		0.02	
Dissolved Potassium	200.7	mg/L		7.	
Dissolved Sodium	200.7	mg/L	250	198.	
Iron	6010	mg/kg			23549
Lead	6010	mg/kg	70		9
Magnesium	6010	mg/kg			6900
Manganese	6010	mg/kg	11,000		493
Mercury	7471	mg/kg	100		0.18
Methylene chloride	EPA 601	ug/L		7.6	
Molybdenum	6010	mg/kg			5
Nickel	6010	mg/kg	500		25
Potassium	6010	mg/kg			679
Recoverable Aluminum	200.7	mg/L		8000.	
Recoverable Arsenic	206.2	mg/L	0.05	3.9	
Recoverable Barium	200.7	mg/L	1.0	40.	
Recoverable Beryllium	200.7	mg/L	0.0000039	0.2	
Recoverable Calcium	200.7	mg/L		5400.	
Recoverable Chromium	200.7	mg/L	250	22.	
Recoverable Cobalt	200.7	mg/L		7.	
Recoverable Copper	200.7	mg/L	1.0	19.	
Recoverable Iron	200.7	mg/L	0.3	16800.	
Recoverable Lead	239.2	mg/L	0.05	3.2	
Recoverable Magnesium	200.7	mg/L		5200.	
Recoverable Manganese	200.7	mg/L	0.05	370.	
Recoverable Molybdenum	200.7	mg/L		5.	
Recoverable Nickel	200.7	mg/L		21.	
Recoverable Sodium	200.7	mg/L	250	220.	
Recoverable Vanadium	200.7	mg/L		27.	
Recoverable Zinc	200.7	mg/L	5.0	34.	
Sodium	6010	mg/kg			110
Total Mercury	245.1	mg/L	0.002	0.06	
Total Solids	160.3	%			91.3
Vanadium	6010	mg/kg	1,000		42
Zinc	6010	mg/kg	10,500		44
bis(2-Ethylhexyl)phthalate	Method 625	ug/L		20.	

Table 4.2.25.3

Analytical Results - Site BH-4

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	BH-4 0687-NG-122,GN-88-0003 001452-0007	BH-4 10'-11.5' 0687-SO-122 GS-88-0001 001221-0009
Aluminum	6010	mg/kg			12687
Barium	6010	mg/kg			52
Beryllium	6010	mg/kg			0.2
Calcium	6010	mg/kg			4037
Chromium	6010	mg/kg	50,000		31
Cobalt	6010	mg/kg			10
Copper	6010	mg/kg	1,850		31
Dissolved Barium	200.7	mg/L	1.0	0.081	
Dissolved Calcium	200.7	mg/L		20.	
Dissolved Magnesium	200.7	mg/L		5.9	
Dissolved Manganese	200.7	mg/L	0.05	0.096	
Dissolved Sodium	200.7	mg/L	250	8.5	
Dissolved Zinc	200.7	mg/L	5.0	0.06	
Iron	6010	mg/kg			23529
Lead	6010	mg/kg	70		7
Magnesium	6010	mg/kg			5652
Manganese	6010	mg/kg	11,000		473
Molybdenum	6010	mg/kg			5
Nickel	6010	mg/kg	500		25
Potassium	6010	mg/kg			692
Recoverable Aluminum	200.7	mg/L		138.	
Recoverable Arsenic	206.2	mg/L	0.05	0.010	
Recoverable Barium	200.7	mg/L	1.0	0.69	
Recoverable Beryllium	200.7	mg/L	0.0000039	0.003	
Recoverable Calcium	200.7	mg/L		51.	
Recoverable Chromium	200.7	mg/L	0.05	0.18	
Recoverable Cobalt	200.7	mg/L		0.12	
Recoverable Copper	200.7	mg/L	1.0	0.58	
Recoverable Iron	200.7	mg/L	0.3	226.	
Recoverable Lead	239.2	mg/L	0.05	0.092	
Recoverable Magnesium	200.7	mg/L		61.	
Recoverable Manganese	200.7	mg/L	0.05	7.0	
Recoverable Molybdenum	200.7	mg/L		0.06	
Recoverable Nickel	200.7	mg/L		0.35	
Recoverable Potassium	200.7	mg/L		7.	
Recoverable Sodium	200.7	mg/L	250	6.5	
Recoverable Vanadium	200.7	mg/L		0.33	
Recoverable Zinc	200.7	mg/L	5.0	0.54	
Sodium	6010	mg/kg			115
Total Mercury	245.1	mg/L	0.002	0.0017	
Total Solids	160.3	%			86.7
Vanadium	6010	mg/kg	1,000		45
Zinc	6010	mg/kg	10,500		47

Table 4.2.25.3

Analytical Results - Site BH-5

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	BH-5 0687-WG-123,GW-88-0003 001452-0001	BH-5 5'-6.5' 0687-SO-123 GS-88-0001 001324-0018	BH-5 15'-16.5' 0687-SO-123 GS-88-0002 001324-0019	BH-5 15'-16.5' DUPLICATE 0687-SO-123 GS-88-0002 001324-0019
Aluminum	6010	mg/kg			5161	9524	11296
Barium	6010	mg/kg			22	34	42
Beryllium	6010	mg/kg				0.2	0.2
Calcium	6010	mg/kg			2523	4762	6977
Chromium	6010	mg/kg	50,000		14	18	22
Cobalt	6010	mg/kg			3	8	9
Copper	6010	mg/kg	1,850		13	20	22
Dissolved Arsenic	206.2	mg/L	0.05	0.004			
Dissolved Barium	200.7	mg/L	1.0	0.12			
Dissolved Calcium	200.7	mg/L		67.			
Dissolved Iron	200.7	mg/L	0.3	0.18			
Dissolved Magnesium	200.7	mg/L		18.			
Dissolved Manganese	200.7	mg/L	0.05	0.28			
Dissolved Sodium	200.7	mg/L	250	28.			
Dissolved Zinc	200.7	mg/L	5.0	0.02			
Iron	6010	mg/kg			9404	22259	23699
Lead	6010	mg/kg	70		6	8	9
Magnesium	6010	mg/kg			2638	6423	8195
Manganese	6010	mg/kg	11,000		241	365	410
Mercury	7471	mg/kg	100		0.18	0.10	0.09
Molybdenum	6010	mg/kg			2	6	6
Nickel	6010	mg/kg	500		13	29	23
Recoverable Aluminum	200.7	mg/L		25.			
Recoverable Arsenic	206.2	mg/L	0.05	0.010			
Recoverable Barium	200.7	mg/L	1.0	0.17			
Recoverable Beryllium	200.7	mg/L	0.0000039	0.018			
Recoverable Cadmium	200.7	mg/L	0.01	0.015			
Recoverable Calcium	200.7	mg/L		73.			
Recoverable Chromium	200.7	mg/L	0.05	0.05			
Recoverable Cobalt	200.7	mg/L		0.04			
Recoverable Copper	200.7	mg/L	1.0	0.11			
Recoverable Iron	200.7	mg/L	0.3	53.			
Recoverable Lead	239.2	mg/L	0.05	0.026			
Recoverable Magnesium	200.7	mg/L		28.			
Recoverable Manganese	200.7	mg/L	0.05	1.1			
Recoverable Molybdenum	200.7	mg/L		0.04			
Recoverable Nickel	200.7	mg/L		0.07			
Recoverable Silver	200.7	mg/L	0.05	0.013			
Recoverable Sodium	200.7	mg/L	250	23.			
Recoverable Vanadium	200.7	mg/L		0.09			
Recoverable Zinc	200.7	mg/L	5.0	0.13			
Sodium	6010	mg/kg			92	111	144
Total Mercury	245.1	mg/L	0.002	0.0002			
Total Solids	160.3	%			87.2	91.1	90.3
Vanadium	6010	mg/kg	1,000		18	32	40
Zinc	6010	mg/kg	10,500		16	39	41

Table 4.2.25.3

Analytical Results - Site BH-6

Parameter	Method	Units	Standards, Criteria and Action Levels Federal/State	BH-6 0687-NG-124,GN-88-0003 001452-0002	BH-6 5'-6.5' 0687-SO-124 GS-88-0001 001116-0003	BH-6 10'-11.5' 0687-SO-124 GS-88-0002 001116-0004
Aluminum	6010	mg/kg			13261	10722
Barium	6010	mg/kg			60	33
Beryllium	6010	mg/kg			0.3	0.2
Calcium	6010	mg/kg			4783	3612
Chromium	6010	mg/kg	50,000		23	21
Cobalt	6010	mg/kg			9	8
Copper	6010	mg/kg	1,850		21	18
Dissolved Barium	200.7	mg/L	1.0	0.070		
Dissolved Calcium	200.7	mg/L		75.		
Dissolved Copper	200.7	mg/L	1.0	0.009		
Dissolved Magnesium	200.7	mg/L		19.		
Dissolved Sodium	200.7	mg/L	250	16.		
Dissolved Zinc	200.7	mg/L	5.0	0.03		
Iron	6010	mg/kg			22609	19751
Lead	6010	mg/kg	70		76	
Magnesium	6010	mg/kg			6848	6998
Manganese	6010	mg/kg	11,000		500	361
Mercury	7471	mg/kg	100		0.20	0.15
Nickel	6010	mg/kg	500		22	20
Recoverable Aluminum	200.7	mg/L		12.		
Recoverable Arsenic	206.2	mg/L	0.05	0.007		
Recoverable Barium	200.7	mg/L	1.0	0.13		
Recoverable Calcium	200.7	mg/L		75.		
Recoverable Chromium	200.7	mg/L	0.05	0.01		
Recoverable Cobalt	200.7	mg/L		0.01		
Recoverable Copper	200.7	mg/L	1.0	0.078		
Recoverable Iron	200.7	mg/L	0.3	16.		
Recoverable Lead	239.2	mg/L	0.05	0.066		
Recoverable Magnesium	200.7	mg/L		24.		
Recoverable Manganese	200.7	mg/L		0.22		
Recoverable Sodium	200.7	mg/L	250	15.		
Recoverable Vanadium	200.7	mg/L		0.05		
Recoverable Zinc	200.7	mg/L	5.0	0.06		
Sodium	6010	mg/kg			120	
Total Mercury	245.1	mg/L	0.002	0.0003		
Total Petroleum Hydrocarbons	3550/418.1 Mod.	mg/kg			2027	
Total Solids	160.3	%			92.0	88.6
Vanadium	6010	mg/kg	1,000		46	41
Zinc	6010	mg/kg	10,500		78	47

4.2.25.1.5 Discussion of Analytical Data

Several organic compounds were detected in samples from the basewide hydrology wells. Concentrations of total petroleum hydrocarbons were generally low and isolated (Figure 4.2.25.8). A soil sample from the 5-foot depth in well BH-6 contained a total petroleum hydrocarbon concentration of 2020 mg/kg. Methylene chloride (7.6 ug/L) and bis(2-ethylhexyl) phthalate (20 ug/L) were detected in a water sample from well BH-3. The bis(2-ethylhexye) phlhalate is probably a result of field or laboratory contamination however the methylene chloride cannot be dismissed as laboratory contamination.

Metals such as aluminum (5200 to 13,300 mg/kg), iron (9400 to 37,200 mg/kg), manganese (240 to 680 mg/kg) and magnesium (2600 to 10400 mg/kg) were detected in soil samples from the site. In general, the lowest concentrations were detected in the soil sample taken at a depth of 5 feet from well BH-5. Water samples also contained total recoverable metals at concentrations as high as 8000 mg/L - aluminum, 16,800 mg/L - iron, 370 mg/L - manganese, 5,200 mg/L - magnesium respectively, in water collected from well BH-3. Dissolved elements ranged from a high of 24 mg/L for magnesium in well BH-3 to a low of 0.004 mg/L of arsenic in well BH-5.

Calcium levels in soil (2500 to 7900 mg/kg) and water (20 to 78 mg/L), sodium levels in soil (92 to 140 mg/kg) and water (total: 6.2 to 220 mg/L, dissolved 8.5 to 198 mg/L), and potassium levels in soil (680 to 750 mg/kg) and water (total and dissolved: 6 to 7 mg/L) are due to the natural mineral content of the surrounding soils. Potassium was detected only in soil and water samples from wells BH-1, BH-3 and BH-4.

Small amounts (less than 80 mg/kg) of other elements such as barium, chromium, cobalt, copper, nickel, vanadium and zinc were detected in

all BH soil samples. Water samples from wells BH-1 and BH-4 contained all of the above elements in the total recoverable form, at concentrations not greater than 0.80 mg/L. Dissolved barium was detected in BH-1 and BH-4 and dissolved zinc was detected in BH-4 all at concentrations less than 0.1 mg/L. Water samples from wells BH-5 and BH-6 contained these total elements at levels less than 0.29 mg/L. Both wells contained dissolved barium and zinc at concentrations less than 0.15 mg/L. Comparatively high concentrations for total recoverable metals ranging from 7 mg/L for cobalt to 40 mg/L for barium were detected in a water sample from well BH-3. This anomoly may have been caused by the high content of sediment in the sample.

Arsenic, lead, molybdenum, and silver were detected in several soil and water samples from the site. Arsenic was detected in soil from BH-1 at a concentration of 0.11 mg/kg. Water samples from all of the basewide hydrogeology wells contained this element as total recoverable at concentrations ranging from 0.005 to 3.9 mg/L. Lead was detected in soil samples from all basewide hydrogeology locations. This metal ranged in concentration from 7.8 mg/kg in well BH-5 to 76 mg/kg in well BH-6. Water samples from the site contained total lead at concentrations ranging from 0.026 mg/L (well BH-5) to 3.2 (well BH-3). Molybdenum was detected in soil samples from wells BH-1, BH-2, BH-3, BH-4, and BH-5 at concentrations ranging from 2.3 to 9.7 mg/kg. Water samples from these same wells contained total molybdenum at concentrations ranging from 0.04 to 5.0. Silver was detected in soil from well BH-1 (4.1 mg/kg) and in water from well BH-5 (0.013 mg/L).

Trace amounts of beryllium (less than 0.5 mg/kg) were detected in soil samples from all test borings at the basewide hydrology wells. This element was also detected as total recoverable in water samples from all wells, except well BH-6, at concentrations of 0.2 mg/L or less. Total mercury was detected in soil samples from wells BH-3, BH-5, and BH-6 at concentrations less than 0.2 mg/kg. Water samples from all

5 wells also contained trace amounts of mercury (0.0002 to 0.06 mg/L). Total recoverable Cadmium (0.015 mg/L) was detected in a water sample from well BH-5.

4.2.25.2 Sampling or Analytical Problems

Sampling or analytical problems that may have been encountered at the basewide hydrogeology sites include loss of samples, cross-contamination of samples, and out-of-control events causing a deviation from the work plan.

4.2.25.2.1 Loss of Samples

No soil or water samples collected for laboratory analysis were lost from the basewide hydrogeology sites.

4.2.25.2.2 Likelihood that Positive Samples were Contaminated in the Field or Laboratory

It is possible that cross-contamination occurred in the field or laboratory. Sampling protocols and field decontamination procedures (Section 3.6.2) were strictly followed during both soil and water sampling. Laboratory QA/QC procedures (Section 3.7.3) were enforced through performance evaluation studies, in-house audits, and audits of spike sample results. However, a water sample from well BH-3 contained bis(2-ethylhexyl) phthalate and methylene chloride at concentrations of 20 and 7.6 ug/L, respectively. QA/QC data indicate that the bis(2-ethylhexyl) phthalate may be attributed to field or laboratory contamination, but the methylene chlorida cannot be dismissed as a laboratory contaminant.

4.2.25.2.3 Analytical Results Obtained Under Out-of-Control Conditions

Six boreholes were drilled as part of the basewide hydrogeology study. Six wells were to be installed; however, 1 of the borings, borehole BH-2, did not encounter water and was backfilled with a volclay slurry.

4.2.25.2.4 Corrective Actions Applied to Out-of-Control Events, Including a Chronology of Rerunning Samples and Controls

Borehole BH-2 did not encounter water and was backfilled with volclay slurry. The USAFOEHL Program Manager was informed of this out-of-control event and agreed to the corrective action. No samples from the basewide hydrogeology sites were rerun.

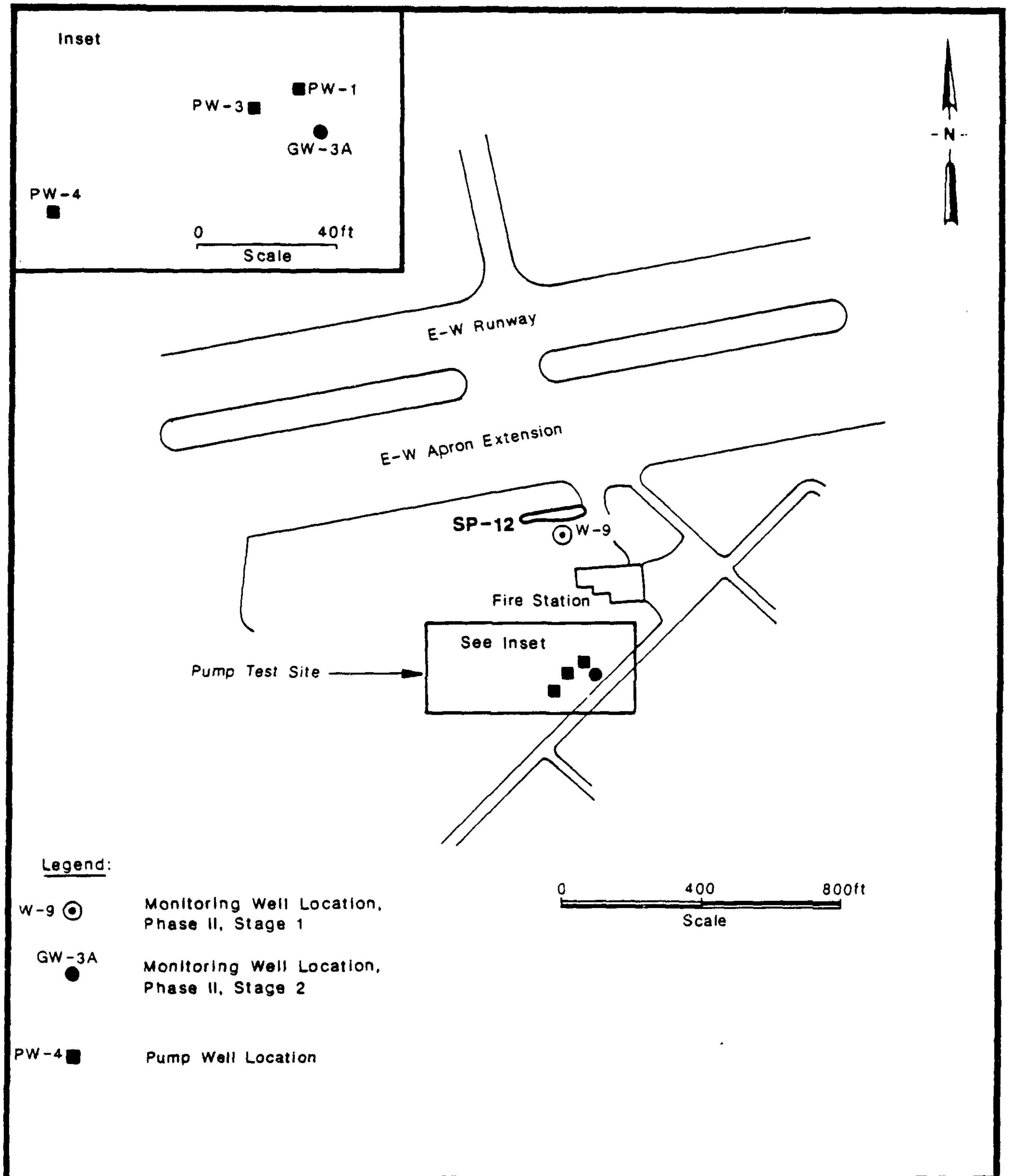
4.2.26 Discussion of Results of the Pump Test

The pump test was completed to determine aquifer characteristics. An uncontaminated location was chosen for the test; a 4-inch diameter pumping well and two 2-inch diameter observation wells were installed for the test (Figure 4.2.26.1). In addition, 1 previously-installed 2-inch diameter well was utilized.

Results from field geologic and hydrologic investigations are presented in the following sections. No samples were collected for laboratory analyses from any of the pump test wells.

4.2.26.1 Presentation of Pump Test Results

Results of the geologic and hydrogeologic investigations are presented below.



LOCATION MAP
PUMP TEST SITE

IRP Stage 3 RI/FS
Elmendorf AFB, AK

Figure 4.2.26.1

4.2.26.1.1 Site Geology

The pump test site was located on flat terrain at an elevation of 176 feet. The site is situated on late-Quaternary coarse-grained glacial outwash deposits consisting chiefly of sands and gravels with some silt. The outwash deposits overlie silty and clayey lascustrine units of the Bootlegger Cove Formation. The top of the Bootlegger Cove Formation is at a depth of 76 feet beneath the site. The site has been graded and capped with a near surface layer of fill which contains some concrete pieces. The surface of the site is covered with a maintained lawn.

4.2.26.1.1.1 Borings

Three test borings were drilled at the pump test site and completed as monitoring wells. Logs of these wells PT-01, PT-03, and PT-04 are provided in Appendix C.

4.2.26.1.2 Pump Test Results

All wells at the pump test site are screened in an unconfined sand and gravel aquifer at a depth of approximately 22 feet. Well PT-04 fully penetrated the sand and gravel layer to a depth of 76 feet, indicating an aquifer thickness of 54 feet. The aquifer is underlain by clay and silt, presumably of the Bootlegger Cove Formation. The gradient of the water table prior to the test was 0.004 feet per feet toward the southwest.

Maximum drawdown observed in the observation wells during the test ranged from 0.12 to 0.36 feet, and the maximum drawdown observed in the pumped well was 1.50 feet. Data were analyzed by methods described by Theis (1935) and Johnson Division, Universal Oil Products Co. (1966, pp. 138-144) for drawdown and recovery data, respectively.

Approximately 12 hours after pumping started (at 1417 hours 24 August 1988) a moderate to heavy rainstorm occurred. The Elmendorf AFB precipitation station, located only a few hundred feet from the pump test site, recorded a total of 0.32 inches of rainfall on 25 August 1988. Most of this precipitation fell during a 4 to 6 hour period in the early morning. Waterlevel data collected during the latter part of the test (after the rainstorm) showed essentially no increase in drawdown as time progressed. An analysis of recovery data indicated that a significant amount of recharge occurred during the test.

Data collected prior to the rainstorm were analyzed to determine aquifer parameters (Table 4.2.26.1). Calculated transmissivities from the 4 wells ranged from 15,300 feet^2 per day to 21,800 feet^2 per day, with an average value of 18,500 feet^2 per day. Assuming an average aquifer thickness of 54 feet, the average horizontal hydraulic conductivity at the site is estimated to be 340 feet per day. These values are very high and many not be representative of aquifer characteristics throughout the site. Calculated storativities from the observation well data range from 4×10^{-3} to 8×10^{-2}.

4.2.26.1.3 Analytical Results

Field analytical results and observations are discussed in the following section. No samples were collected for laboratory analyses.

4.2.26.1.3.1 Field Analytical Results and Observations

No indications of contamination were observed or recorded at the pump test site. However, well PT-02 drilled at the site originally proposed for the pump test near building 10-300, was found to be contaminated. HNu readings of 3 ppm on a soil sample taken at 16 feet and 120 ppm on a soil sample taken at 26 feet were recorded. Also a strong odor of petroleum was detected. The water table sample had an odor and HNu reading of 20 ppm. The pump test site was relocated due to the contamination.

Table 4.2.26.1 Pump Test Summary of Results

Well Number	Type of Data	Distance from Pumped Well (ft)	Calculated Transmissivity (ft^2/day)	Calculated Hydraulic Conductivity[1] (ft/day)	Calculated Storativity	Method of Analysis
GW-3A	Drawdown	16.6	18,000	330	0.024	Theis (1935)
GW-3A	Recovery	16.6	17,500	320	0.013	Calculated recovery[2]
GW-3A	Recovery	16.6	20,200	370	N[3]	Residual drawdown[2]
PT-03	Drawdown	14.9	19,700	370	0.0044	Theis (1935)
PT-03	Recovery	14.9	19,900	370	0.0036	Calculated recovery[2]
PT-04	Drawdown	79.2	21,800	400	0.081	Theis (1935)
PT-04	Recovery	79.2	16,000	300	0.022	Calculated recovery[2]
PT-01	Drawdown	pumped well	N[3]	N[3]	N[3]	
PT-01	Recovery	pumped well	15,300	280	N[3]	Calculated recovery[2]

[1] Assuming uniform aquifer thickness of 54 ft

[2] See Johnson (1966) pp. 138-144

3Indicates that the value could not be calculated (Data not suitable for analysis)

4.3 PRIORITIZATION OF SITES FOR REMEDIAL ALTERNATIVES

The prioritization of sites for remedial alternatives as presented in the preceding discussion of results section is summarized in Table 4.3. The sites are divided into 5 categories as follows:

- o Sites to be included in the feasibility study.
- o Sites given a high priority for further investigation.
- o Sites given a medium priority for further investigation.
- o Sites given a low priority for further investigation.
- o Sites that require no further action.

TPH and/or BETX were detected above allowable limits in samples taken from the 7 sites listed for inclusion in the feasibility study. The potential for offsite migration exists at each of the 7 sites and 1 of the sites is visibly contaminated. Seven sites require no further action as contaminant levels were below allowable concentrations. The remaining 18 sites require additional investigation before performing a feasibility study. The basis for categorization of sites was discussed in Section 4.1.4.

Additionally, it was determined that 4 sites, D-5, D-7, D-13, and NS-2, should be combined since the site boundaries overlap, similar contaminants were detected at the sites and combining the sites allows for reasonable evaluation of all data and remedial alternatives. In addition, sites SP-4 and SP-11 should be combined as the sites are near each other and may impact each other.

In general, additional data is needed to determine the extent of contamination at each of the sites which require further investigation, including the 7 sites which will be included in the feasibility study.

TABLE 4.3 PRIORITIZATION OF SITES FOR REMEDIAL ALTERNATIVES

SITES TO BE INCLUDED IN FEASIBILITY STUDY	PRIORITIZATION OF SITES WHICH REQUIRE FURTHER INVESTIGATION			SITES WHICH REQUIRE NO FURTHER ACTION
	HIGH	MEDIUM	LOW	
D-16	D-5	D-17	D-15	D-3
IS-1	D-7	IS-3	SP-13	IS-2
SP-5/5A	D-13	IS-4		IS-5
SP-7/10	SP-1	IS-6		SP-12
SP-15	NS-2	IS-7		SP-14
		IS-8		NS-3
		SP-2/6		S-6
		SP-4		
		SP-11		
		NS-1		